HEALTH LECTURES

FOR THE PEOPLE.

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PREFACE.

The feeling that very much of the suffering and weak health which is so apparent in all classes might be prevented if there were an effort made to spread knowledge of the laws of Health, led to the delivery of the following Course of Lectures. That the want of knowledge on the subject, and the necessity for it, was recognised, has been made quite clear by the interest which the lectures excited, and the success which attended the whole scheme.

These lectures were published as they were delivered, but it seemed desirable to present them in a collected form, so that they might be studied by those who wished to do so in reference to their bearing one upon another.

In commending the study of health to every one, old or young, I wish to notice some objections which are urged against it, with what, at first sight, seems to be a show of reason, viz., that to become concerned about Health is apt to foster fanciful anxieties, and to lead to valetudinarianism; and that there is something unworthy, or at least trivial, in caring for the body. But these are objections which cannot stand a scrutiny. We are bound to know and obey the laws of God, not as they concern part of our being, but the whole, and the better we know the laws which govern us, the fewer will be the vague terrors which will assail us. It is only darkness and ignorance that can terrify.

A little reflection also on the relative values of things will teach us when we must be careful of, and when we must ignore, the body. The body is the means by which we work and think, and if the necessary amount of food, rest, air, and exercise are taken, energy is liberated in the form of good work or wise thought. If more than is necessary is taken, if the body is indulged, the happy moment of development never comes, and dull work and dull thought make Jack as dull a boy as would ever "all work and no play."

Self-denial is the law of development; it is the detaching ourselves, with a pang it may be, but with free will, from the grasp of the lower, and the passing into the guidance of the higher desire. Comfort there must be—comfort for the comfortless—but wise self-restraint for the comfortable.

The oldest record of man's history tells of a fall in condition from pure greediness of desire. God knows what was lost in those early days, but the last, divinest Teacher of the world struck again the key-note sounded by divine wisdom at Creation, and declared that through self-denial alone we should reach not simply Health, but Immortal Life.

F. E. M. T.

EDINBURGH, 11*th February* 1881.

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CARE OF THE BODY.

By Professor FLEEMING JENKIN.

Professor Fleeming Jenkin, in delivering the first of a Course of Lectures on Health, in the Watt Institute, on the evening of Saturday, the 20th November, said:—

I cannot suppose I have been chosen to deliver this Introductory Lecture because I have any special knowledge of the body; I rather apprehend that it is because I have shown that I consider the Care of the Body to be a duty, and a very important duty. So far as I have been able to do anything up to the present time, I am afraid that my efforts have been of very little use, except to those who are well-to-do—who are rich. To-night, I feel it a very great privilege, that I am enabled to say something which, I trust, may be of benefit to the poor; and it is to the poorer among you that I am about to address myself to-night.

The first proposition which I lay down is this—and it lies at the root of the whole Course of Lectures which is to be delivered here—it is, That the Care of our Body is a Duty. Many amongst you may think it is very unnecessary that this should be insisted upon, but I am not so sure of that There is a certain number of people who think that it is rather a selfish thing to take care of our own bodies; that it is a noble thing to take care of our mind, but that we may neglect the body while doing this. They think that it is a still more noble thing to take care of our souls, but sometimes think we can better take care of our souls if we mortify the body. I think both these propositions are complete fallacies. In all our work we make use, and must make use, of our body; and it seems to me utterly absurd to suppose that when that instrument is out of order we can better perform any of the functions for which it is adapted. Therefore I think that it is our duty to take care of our bodies. We can neither work, nor study to right advantage, if our body is out of order; and when I come to our moral nature, I find something more to say. I wish to point out to you, that if our health is not good, we are subject to special temptations in consequence of the imperfection of that health. When we are ill, we are especially liable to be out of temper. We are especially liable to seek for some relief by means which are not the best; sometimes by drink, sometimes by other forms of indulgence, of which we can hardly approve. What is, after all, our highest duty, or may I say, our complete duty? Our complete duty is certainly to love our neighbour, and to love God. Now, I think that in certain states of health it is very difficult indeed to love our neighbour. If we are thoroughly out of temper, that feeling of kindness becomes almost impossible. And so with the second duty. Just let us ask ourselves for a moment what we mean, when we say that we should love God. I don't wish to preach, but surely one can hardly love God without feeling a certain satisfaction, a certain contentment, in the world, and a recognition of the beauty that is all around us. Is it possible for us when out of health to have that feeling? I do not say that it is impossible for a sick person to love God; it certainly is not impossible, but I venture to say that if you are out of health, you are under much greater temptation than when you are in health; that you will then find it very much more difficult to fulfil those two great duties which sum up all others, than when you are in good health, and therefore it is your duty to avoid running into temptation; if you wilfully sacrifice your health, you do run into temptation. I quite admit that at the last our actions, however much hampered by bodily infirmity, will be judged mercifully, but that is no reason why those who can take care of their bodies should not do so. Now, that care is not selfish. Some people think that taking care of their bodies is selfish, but my impression is that the selfishness is utterly on the other side; that when people neglect to take care of their bodies, it is from indifference and ignorance that they do it. My impression is, that idleness, indifference, and ignorance, are selfish, and therefore that there is little selfishness in taking care of our bodies, even if we are only looking after ourselves. There is little heroism in running needless risks.

Let me take a case. The child of a Princess was suffering from diphtheria. The Princess took no precaution, and, with a certain heroism, kissed the child, caught the disease, and died. Now, did that Princess do her duty? I venture to think not. It is the duty of a mother to take care of her own health, for the sake of all those to whom she is dear; and, like all other duties, it calls for heroism, and for heroism of a higher kind, not to give way to the impulse of the moment. We could not but admire the Princess for what she did, but precisely because her action commands our admiration; on that very ground, I venture to say that it was not the truest duty that could have been performed under such circumstances.

I have taken the strongest case I could find against my proposition, because the sympathies of all will be for the mother. If we, then, owe this duty to ourselves, to look after our own bodies, how much more do we owe the duty to others to take care of their health? We all know that we must take care of the minds and of the souls of our children, but we must also take care of their bodies, for all those arguments I have used with reference to ourselves apply with tenfold force to those under our charge.

There are many ways in which this can be done, even by the poorest—choice of nourishment, the amount of sleep, the air they breathe, danger from infection;—all these things can be looked after to some extent by all, and it is the duty of all when they know what to do, to do it. Fresh knowledge imposes fresh duties, and no one who attends the course to be delivered here, will go away without having been subjected to fresh duties. When they *know*, then they must *do*, and that is the reason why I ask you to come here.

Now, not only have we duties to our own families, but we have duties to strangers also, and these duties can be performed not only by the rich, but also, to a very great extent, by the poor. It is possible by a very little carelessness, by what may seem very pardonable carelessness, to spread infectious disease. Now that carelessness is not pardonable. When you come to understand how these infectious diseases are spread, it will become your duty then, at considerable self-sacrifice, to take no part in so spreading these diseases. There are certain illnesses, such as scarlet fever and diphtheria, which are spread by means of milk. It is incredible how slight a connection with a source of disease is necessary in order to render that milk thoroughly deadly poison. It may become your duty to sacrifice your wages rather than have any part whatever in meddling with that milk. You have all heard of the good Samaritan. He did not take care of either the mind or the soul of the sick man; he took care of the body. The poorest among you may have the opportunity of taking care of your neighbour's health. You will act as the good Samaritan acted if at any sacrifice of your own convenience you refrain from acts tending to spread infectious disease. The milk distributer who is exposed to infection must say to his master—"I cannot any longer distribute this milk because I would be spreading disease, or you must see that I am thoroughly disinfected; otherwise I must for a time give up my employment."

There is also the duty of being cheerfully obedient to all those laws which are passed with the object of preventing the spread of infection. Thus you should submit, and cheerfully submit, to inspection. We have a system of inspection already in Edinburgh, but I wish we had more of it. You should show a submission, and a cheerful submission, to having your children and yourselves properly vaccinated. Further, there is a duty calling upon you for active interference—the duty of making complaints regarding any nuisances that may exist in your district. Lastly, you have political duties connected with this subject—you should support by your votes those who take an active interest in sanitary matters.

It may, however, be said, that we do not know anything at all about the matter, that we who set up as authorities are but as "the blind leading the blind." This is but one of the forms of want of faith in those gifts and powers which God has given to man to know things, and by means of that knowledge to combat all these evils. A man that has faith believes that good is possible, that progress is possible, that duties do exist, and that to some extent we can perform them, that we can know what to do, and how to do it, and therefore the man of faith works. The man who has no faith doubts whether there is any good or not. If he is certain of anything, he is certain that those who pretend know do not know. The consequence is, that the man without faith is idle and indifferent, and therefore what I am preaching is to give you faith; and these lectures ought to give you a reasonable faith in the possibility of action, and in the reality of our knowledge.

It is proved by actual experience that external circumstances have a very great influence upon man's health. Under proper sanitary conditions the death rate ought to be no more than 12 or 13 per 1000, but in this town, which is a fairly healthy town, the annual death rate is somewhere about 21 or 22 per 1000. In Dublin, I am told that the death rate is 40. Half these lives, then, are simply sacrificed by imperfect, by bad, conditions of health. And when I say 40 out of every 1000 die, I ought, taking into consideration the greater number who die among the poorer classes, to say, for certain poor districts of the town, 50 or 60; so that three times more people die in certain parts of Dublin than might do under more favourable conditions. At Hampstead the death rate is only 13; and in New Zealand it is only about 12. Then, taking the case of children. In a certain part of London, where they are well cared for, they die at the rate of 8 per 1000, while in the poorer streets they die at the rate of 30 per 1000. In Geneva, in the sixteenth century, when little attention was paid to sanitary matters, the probability of life when a child was born was only five years. No child could count upon living more than five years; but in the eighteenth century, when a little more had been done, it rose to 27½ as the probability of life, and this was simply due to external circumstances. High death rates are no doubt due to conditions which cannot all be removed, but they are also partly due to the ignorance that prevails on these matters, and which can be removed. Therefore it is impossible to say that attention to these things is useless.

Now the present lectures are intended to show the poor what they themselves can do to render the conditions of life more favourable. It is the duty of the town authorities, and one to which they are by no means blind, to make the conditions of life better from year to year; but, as the Lord Provost has said, a great part of their pains must be thrown away unless you all co-operate.

Dr RUSSELL will come first, and say what may be done by a judicious selection and preparation of food. Of course we all know that the poor cannot command as good food as the rich; but many of us know that a great difference can be made as to healthy and unhealthy food, by attention to circumstances that seem extremely minute. Dr Russell may tell you when to drink water, and in what quantities. He may tell you that coffee or tea taken with meat is a bad thing; and that food eaten when we are breathless, or hurriedly swallowed, is prejudicial to health. He will tell you of different kinds of food of equal price, but some of which are more nourishing than others—a very necessary thing for the poorer classes to know. He will tell you as to the different modes of cooking food, and that pleasant food does not mean gluttony but good nourishment. He will speak of nutritious foods, such as Indian corn, and maize, against which a prejudice exists. I myself remember the famine in Ireland, when I was a boy; a prejudice then existed against Indian corn—an unfounded prejudice, which still, I suspect, exists in this country at the present day.

Dr FOULIS will follow, with a lecture on "Blood and its Circulation." He will speak of cuts, of injuries to varicose veins, and to the arteries. He will tell you what healthy blood means, and what it does. He will show how to secure healthy blood in children, so that they may escape rickets and malformations; and he will show you the actual circulation of the blood by means of very beautiful apparatus.

Dr Wilson will lecture on "The Lungs." He will speak of the action of the air on the lungs, the kidneys, and the skin. He will say what pure air is, and how bad air acts. He will show how fresh air may be introduced into a poor house without producing draughts. There is a distinct scientific connection between the want of oxygen in the air and a desire for drink. Sleeping with an insufficient supply of air in a bed-room tends to produce consumption. In Vienna there were two prisons managed by the same authorities, and indeed there was no difference between them, so far as the evidence goes, except that the one was well ventilated and the other not. The result was, that six times as many died from consumption in the one as in the other. From day to day we get fresh facts bearing out this general conclusion, that want of fresh air tends to produce consumption. It is well known that in the ill-built Highland cottages consumption is exceedingly rare. Some of the proprietors, however, improved the dwellings, and the death rate from consumption rose as soon as good windows and good walls were built. The people slept in close air, and the death rate from consumption immediately increased among the same population. There is no scientific fact better established than the connection between consumption and want of fresh air. I do not, however, ask you to believe that draughts are good, and it will be the duty of the lecturer to show how to avoid them.

Dr Annandale will lecture on "Accidents and Wounds." He will show that good health lessens the bad effects of accidents, and will give simple rules for emergencies and for nursing. He will also say when it would be best to take an injured person to the Hospital, and when it would be best for him to be taken to his own home.

Dr Angus Macdonald has not sent me any notes of his lecture. It is, however, clear that a lecture treating specially of women's health ought to be one of the most valuable of the series. Women often fall into permanent ill health from ignorance of very simple matters, as when, and how far, to walk; how to avoid the dangers of overstraining when lifting a patient in bed. Those who are about to become mothers are often ignorant of many dangers which they run.

Dr Underhill will follow with a lecture on "Children," and will speak of such matters as when, and how, to wean a child, of the food to be given at different ages, of sleep, of warmth, and of clothing. It is clear that there are many things which rich and poor have yet to learn on this subject.

Dr Macadam will lecture upon "Water." Now water is a great vehicle for the spread of infection. There is a whole class of diseases habitually spread and communicated by means of water. What the protections are that you can all take, will be explained to you by Dr Macadam. I observe that he is going to speak of the abuse as well as the use of water. You may ask, How can water be abused? and I will tell you one mode, Simply by allowing it to run to waste. The best method of supplying water is that known as the constant supply, by which the water is drawn direct from the mains without exposing it for a single instant in a cistern to the risk of infection. But what is the great difficulty in the way of the introduction of that system? Simply that people have not intelligence enough not to allow the water to run to waste. Therefore it is the duty of all people to prevent the waste of water, and to use it intelligently.

Professor Fraser will lecture on "The Use and Abuse of Stimulants—Alcohol and Tobacco." I know nothing about this subject, and therefore I will say nothing about it; but I am perfectly convinced of its great importance.

Dr Smart will follow, with a lecture on "Preventable Diseases and their Causes;" and in connection with that subject will speak of the spread of disease by means of milk, water, air, clothes, and so forth. He will also explain the objects of registration of disease.

These lectures, if well prepared, well attended, and well followed, cannot but have a good effect, and it is the duty of all who can to attend them. Those who attend must put in practice what they then learn.

I will now speak of what the *law* will do to help you; but to obtain that help you must co-operate with the authorities, and use the facilities which the law has given you. For instance, it is the duty of the Medical Officer of Health and of his Staff in this town, to prevent overcrowding; but how can he do that unless some one complains? Make that complaint whenever a difficulty arises, and not only for rooms in which you have to live, but if you know that on the stair in which you live there is overcrowding, it is your duty to give the necessary notice. It is the duty of the Medical Officer of Health to remove accumulations of rubbish, which are invariably dangerous. It is the duty of the officers of the town to see that persons suffering from infectious disease shall cause no danger to dwellers in a house; to cause dead bodies to be buried before they become offensive; to disinfect rooms which have been occupied by persons with an infectious disease; and to see that defects in drainage and water supply be remedied; but to enable these provisions of the law to be put in force, you must give notice that the occasion has arisen. Do not be afraid of complaining; and if you are not well received by the officers, go to headquarters. You have your Town Councillors, who will be happy to see that your complaint is attended to. The assistance you will obtain from the town is not a charity. It is a right.

Doctors and medicine can always be had. They can be got from any of the Dispensaries in town—the Royal Public Dispensary, the New Town Dispensary, the Missionary Dispensary, the Fountainbridge Dispensary, and the Grove Street Dispensary. In all cases of illness you should call in a doctor; and in sending for him be careful to give your address in full. Dr Littlejohn tells me that cases are sometimes not attended to from a difficulty in finding out the correct address, for medical students with a large number of cases on their hands have not time to hunt about for the particular door in a long common stair. It is no doubt difficult to give a full address in a common stair in which a number of families live, but give it as fully as you can. And I take this opportunity of suggesting that some plan should be introduced of numbering or lettering the doors in a common stair, so as to enable doctors and others to find out at once the persons sought.

In concluding, I wish to combat indifference and idleness under two very specious forms. I will call these two forms sins —two presumptuous sins. These two sins are, unfounded trust in one's self, and unwarranted trust in Providence. You will meet everywhere, men and women who are guilty of the first of these two sins. They say that they disbelieve that there is such a thing as infection, that they never catch diseases; they say they understand all about drains, and do not want anybody to teach them. As to going into an ill ventilated room, they say that gas never does them any harm; that they know what is wrong better than the doctors; that vaccination is dangerous; that science is rubbish; and as for eating and drinking, they will eat and drink what they like, when they like, and how they like. There are women who dress in ways which are extremely unhealthy, who will neglect all warnings in such important matters as their behaviour during child-bearing. There are women who think they know by instinct how to manage children, and do not need to be taught anything about it; who know by instinct how to nurse, or who know of some old woman or other who will give much better instruction on the subject of health than any doctor. These are not people to be followed.

Science is not infallible, but you may be certain that those who address you here have at least had a good training; you may follow their advice with a good conscience. It is presumptuous to take the responsibility of dispensing with proper guides as to the care of the body, both your own and that of others; use your judgment and self-reliance in choosing your guides; avoid false guides, avoid quacks, avoid people who are ignorant, and who have any motive to mislead.

Now, to come to the other form of sin, what is commonly called, and utterly miscalled, trust in Providence. When a person says, "Oh! disease comes from above;" I quite admit that all disease comes from above, but those who say they trust in Providence, very often make use of that expression merely as an excuse for their own idleness. They will not take the trouble to learn; they remain ignorant. They will not trouble themselves to take any precautions, or to apply remedies. They seek for no improvement, and they simply excuse themselves with a completely lame excuse, by saying they trust in Providence. They do nothing of the kind. Where our idleness or indifference will kill or injure others, have we the slightest right to say we trust in Providence? In putting up a scaffolding would you make a loose knot, or put in a rotten plank, and then send men on to the scaffolding, saying you trusted in Providence to make the knot tight and the wood sound? Would you mix poison with your food, and then partake of it, saying you trusted in Providence it would have no ill effect? If you dare to send out tainted milk, which is nothing else than poison, can you say that you trust in Providence it will do no harm?

It is simply untrue, then, when people say they trust in Providence in this way, and I say it is a sin. A doctor in this town told me of an instance where a lady had some children who had just recovered from scarlet fever. They were becoming rather noisy, and she was anxious to get them sent back to school. Accordingly she asked the doctor if she might do so, but the children were just at that stage when there was a considerable risk of their spreading the infection if they came into contact with others, he therefore told her it would be dangerous to send them to school. "But, doctor," she asked, "will my children themselves run any risk of danger?" "Oh, no, the danger is for other people's children." "Oh, then I'll send them back to school to-morrow." Now possibly that lady might be so ignorant that she was not aware of the great risk there was of spreading the disease, but after the warning she received she was committing a grave sin in sending her children to school. What mockery it would have been in her to say, that she expected Providence to protect the other children from the consequences of her selfish act.

We believe that Christianity is an active religion, as much opposed to this blind fatalism, which goes by the name of trust in

Providence, as it is possible to be. I think, and fervently believe, that we must trust in Providence, and that we have nothing else to trust to. But when and how are we to trust in Providence? We must always trust in Providence for the successful application of remedies when we take precautions against the spread of disease, when we eat, and when we drink. We must do all these things with faith in God's laws. Would a soldier in command of a company of troops, and with a wall near him, behind which they might get shelter, ask them to stand in front of that wall, telling them he trusted in Providence they would not be shot by the bullets of the enemy? Why that would be a pure mockery, and a sin against God's laws. The soldier must trust in Providence, the doctor who goes into a fever ward must trust in Providence, after they have done all they can to protect themselves; and so it is with us. After we have used all the faculties which God has given us, then we may boldly trust in His mercy, not expecting miracles to be worked on our behalf, but with a firm confidence in His goodness, as shown in the excellence of all His laws.

FOOD AND DRINK.

By Dr J. A. RUSSELL.

On the evening of Saturday, the 27th November 1880, Dr J. A. Russell delivered the Second of the "Lectures on Health," in the Watt Institute, his subject being "Food and Drink." He said:—

The subject of Food and Drink is one so large, that in a single Lecture I can only hope to give a few leading facts, and to enunciate some principles which may explain those facts, and other facts with which you may be acquainted. Food is required for three chief purposes:—firstly, to replace the losses continually taking place from the body; secondly, to maintain the animal heat, or in other words, to supply warmth—our clothes are only for the purpose of keeping that heat in, and it is from our food that the heat itself is derived; and, thirdly, to supply force for performing work. A man is found to require from one-twenty-sixth to one-twentieth of his weight in solid and liquid food in twenty-four hours, or $\frac{1}{105}$th part of his weight of water-free solids, and by this term is meant solid food, after the proportion of water contained in it has been deducted.

On examining the following table, giving the composition of different kinds of solid food, it will be seen that the majority of them contain much water. If you look, for instance, at even such a dry food as cheese, you will see that it consists of more than one-third of its weight of water.

NUTRITIVE VALUE OF FOODS.—(Letheby.)

Substances, 100 Parts.	Water.	Fibrine Albumen, etc.	Starch, Sugar, etc.	Fat.	Salts.	Carboniferous.	Nitrogenous.	Total Nutriment.
Human Milk, - - -	89	3·5	4·2	3·0	0·2	11·4	3·5	14·9
Cow's Milk, - - -	86	4·5	5·0	4·1	0·7	14·8	4·5	19·3
Skimmed Milk, - - -	87	4·5	5·0	2·7	0·7	11·5	4·5	16·0
Butter Milk, - - -	87	4·5	5·0	0·5	0·7	6·0	4·5	10·5
Beef and Mutton, - -	73	19·0	..	5·0	2·0	12·0	19·0	31·0
Veal, - - - - -	77	19·0	..	1·0	0·6	2·4	19·0	21·4
Poultry, - - - -	74	21·0	..	3·0	1·2	7·2	21·0	28·2
Bacon, - - - -	20	0·8	..	70·0	1·3	168·0	0·8	168·8
Cheese (Cheddar), - -	36	29·0	..	30·0	4·5	72·0	29·0	101·0
,, (Skimmed), - -	44	45·0	..	6·0	5·0	14·4	45·0	69·4
Butter, - - - -	15	..	..	83·0	2·0	199·0	..	199·0
Eggs, - - - - -	74	14·0	..	10·5	1·5	25·0	14·0	39·0
White of Egg, - - -	78	20·0	..	..	1·6	..	20·0	20·0
Yolk of Egg, - - -	52	16·0	..	30·0	1·3	72·0	16·0	88·0
White Fish, - - -	78	18·0	..	3·0	1·2	2·4	19·0	21·4
Salmon, - - - -	78	17·0	..	4·0	1·4	9·6	17·0	26·6
Eel, - - - - -	80	10·0	..	8·0	1·3	19·2	10·0	29·2
Wheat Flour, - - -	15	11·0	70·0	2·0	1·7	74·8	11·0	85·8
Barley-meal, - - -	15	10·0	70·0	2·4	2·0	75·8	10·0	85·8
Oat-meal, - - - -	15	12·6	62·0	6·0	3·0	76·4	12·0	88·4
Rye-meal, - - - -	15	9·0	66·0	2·0	1·8	70·8	9·0	79·8
Indian-meal, - - -	14	9·0	65·0	8·0	1·7	84·2	9·0	93·2
Rice, - - - - -	14	7·0	76·0	0·3	0·3	76·7	7·0	83·7
Haricot, - - - -	19	23·0	45·0	3·0	3·6	52·2	23·0	75·2
Pease, - - - -	13	22·0	58·0	2·0	3·0	62·8	22·0	84·8
Beans, - - - -	14	24·0	44·0	1·4	3·6	47·4	24·0	71·4
Lentils, - - - -	14	29·0	44·0	1·5	2·3	47·6	29·0	76·6
Wheat Bread, - - -	44	9·0	49·0	1·0	2·3	51·4	9·0	60·4
Rye Bread, - - -	48	5·0	46·0	1·0	1·4	48·4	5·3	53·7
Potatoes, - - - -	74	2·0	23·0	0·2	0·7	23·5	2·0	25·5
Green Vegetables, - -	86	2·0	4·0	0·5	0·7	5·0	2·0	7·0
Arrow-roots, - - -	18	..	82·0	..	..	82·0	..	82·0

In this table the carboniferous matter is calculated as starch; 10 of fat being equal to 24 of starch.

THE SOURCES of food are mainly in the animal and vegetable world. We differ from plants in this respect, that they take up the ultimate elements and build them up into food for themselves, but we require to have them built up into structures of a certain complexity before they are fitted for our nourishment. We are like the bricklayer, who cannot build a wall from the clay of a brick-field, but must have it first shaped and burned into bricks for him. It is possible that in the future we may have the power of building up elements that are just now furnished to us by either the animal or the vegetable world. It is a thing to look forward to, a thing that I expect our chemists will yet accomplish; so that by synthesis of the ultimate elements they will give us food prepared without the intervention of plants or animals. I can take an article of food and resolve it into its original elements, but it is a different thing to build them up again. For instance, I take this white sugar, which is composed of carbon, or coke, and water. It is easy enough to remove the water from the carbon, by means of this chemical liquid, which has such an affinity for water, that when poured on the sugar it withdraws all the water, and the sugar is converted into a black spongy mass of charcoal. What we desire is, that our chemists shall discover for us how to put coke and water together to make sugar, so that instead of going to the cane-fields of the West Indies, or the beet-fields of France, we may apply for sugar at the nearest coal-mine.

THE ELEMENTS of our food are five in number. WATER.—Man requires from two to four pints a-day of water in addition to the water contained in solid food. ALBUMENOIDS OR ALBUMINATES.—Then we require to have a substance called albumen, or some modification of it. You see an example of pure albumen in the white of an egg; and in every diet which is to sustain life we require to have some substance analogous to the white of an egg. CARBO-HYDRATES.—The third element we require is a portion of a substance analogous to sugar or to starch. These may be called carbo-hydrates. FATS.—Fourthly, fat must be present in some shape or form; and, finally, some SALTS. These elements must be, each and all of them, present in every diet which is to sustain life for a lengthened period. Taking these in detail, as I shall do, and making some remarks upon each, we can look at the sources from which we get them.

ALBUMENOIDS OR ALBUMINATES.—By referring to the table we see that albumenoids are present in salmon, the white of egg, the yolk of egg, and milk. In beef and mutton they are present to the extent of 19 per cent; and you will also see from this table that they are contained in many vegetables, so that we have the sources of the albumenoids both in the animal and vegetable worlds, the difference being, that in the vegetables, generally speaking, they are not so accessible to us, not so capable of assimilation, and not so digestible. Without further change we can eat the flesh of an animal and be nourished thereby, but it is difficult for us to get albumenoids from vegetables without cooking, while from many it is impossible, even with the aid of cooking, to get them. An animal, however, can extract these albumenoids for us. The ox, for instance, eats grass for us, and converts it into a digestible form, which we can then consume in our own bodies. The ox is furnished with a stomach which enables it to digest woody fibre and cellulose, substances which defy our stomachs. With the aid of cookery we have a very abundant cheap and accessible store of albuminates in the vegetable world

Albumenoids are more easily digested after cooking than before. Some people imagine that the white of an egg is more easily digested in its raw state, but that is not so; if it be swallowed in its ordinary state it is much longer in being digested than when cooked, though if whipped, it is so divided that it affords a large surface for contact with the gastric juice, and it is therefore quickly attacked.

Albumenoid substances are remarkable on account of containing a large proportion of nitrogen in their structure. The others contain no nitrogen; and any substance which does not contain a large amount of nitrogen will not build up the tissues of the body. The special functions of albumenoid substances is to repair the tissues of the body, to build up the body, and subserve the purpose, in some cases, of furnishing animal warmth and the force for work; but for the latter purposes they are wasteful food. When animals are fed on food from which albumenoid substances are totally wanting they rapidly lose substance, and die from what physiologists call nitrogen starvation. At the same time, albumenoid substances alone, or many of them, at all events, are not sufficient for carrying on the functions of the body for any time. Gelatine will not keep a dog alive for any length of time. In fact it dies rather sooner than if starved out and out. The albumenoid substances are digested in the stomach by the gastric juice.

The secretion in the mouth does not contribute much to their digestion, and although it is necessary to chew the albumenoids, the reason of that is to divide them finely, so that they may come into intimate connection with the gastric juice in the stomach. Albuminates cause a quick change and renewal of the tissues of the body, and hence are valuable in great labour.

As the albuminates are the main source of nitrogen, while the carbo-hydrates and fats are the chief sources of carbon required by the body, it is sometimes convenient to estimate diet according to the nitrogen and carbon contained in it—the nitrogen being looked upon as the chief tissue-building element, and the carbon as the force and heat-giving one.

Fats are equally necessary with the albumenoid substances, although they do not directly tend to the upbuilding of the body. The fats are one of the great sources of animal heat and force for work. Their use for producing heat every one knows, from the way in which they are used in the Arctic regions. You all know how the inhabitants of these regions eat fat to a large extent, and eat it in a form which to us would be disgusting. I remember the late Professor Pillans telling how, in his young days, and that will be nearly a hundred years ago, the street lamps used to be extinguished in Leith, through the Russian sailors who came into the town drinking the train oil contained in them. When people have to eat a diet in which fat is deficient, they begin to feel it very soon. In the Zulu war, at the siege of Ekowe, the troops under Colonel Pearson suffered from the want of fat. You may remember seeing a letter in the papers from one of the officers, stating that they attempted to use the grease intended for the waggon wheels, but found it too nauseous.

Fats are very important, not only for affording animal heat and force for work, but also as tending to the assimilation and digestion of the other substances of a diet; and albumenoid substances are not properly digested unless in the presence of fat. Butter is the most agreeable way of taking fat when we have to take it by itself. Butterine or oleomargarine, which is made of mutton suet or lard, mixed with milk to give it the flavour of butter, is a perfectly wholesome fat, and the only objection to it is, that many unprincipled dealers sell it under the name of butter. If honestly sold, at an appropriate price, under its own name, it would be a most legitimate article of commerce, and one which would be welcomed as affording a good source of fat for the people. Fats are rather hard to digest by themselves, and therefore one easily digested like butter is very valuable. That they assist in the digestion is shown by the administration of cod liver oil in small doses. It is then given, not so much for the sake of the small quantity of fat contained in a teaspoonful of oil, but to promote the digestion and assimilation of other substances. In fact it is sometimes given in cases of stoutness arising from indigestion, in order to make the patient thinner. The late Professor Bennett alleged that the dearness of butter was one of the causes of consumption.

Now fat is contained in a large number of articles of food, as you will see by referring to the table of composition of foods. Human milk, for instance, contains 3 per cent; bacon, 70 per cent; wheat bread, 1 per cent; rye bread, 1 per cent; and potatoes ·2 per cent, being only one-fifth of that in bread.

Carbo-hydrates, such as sugars and starches, are largely contained in vegetable sources of food. They have no nitrogen in them, and therefore are not capable of nourishing the tissues of the body by themselves. Within the body they are changed into fat, and largely assist in the supply of heat and force for work. Arrow-root consists entirely of water and starch. Starch must be cooked in order to be digested, because the covering of cellulose, containing the starch granule, requires to be ruptured, and the digestive ferments, which act more particularly upon starch, cannot take effect until the covering has been broken. Starch is easily digested by the active principle contained in the saliva or spittle, and therefore it is desirable that farinaceous food, containing starch, should be slowly masticated in the mouth, for the purpose of mixing it with the saliva. The active principle contained in the saliva exercises a chemical influence upon starch, which very rapidly changes it into a form of sugar. This action continues within the stomach for a short time after the starch is swallowed, but the gastric juice stops the action after it has made its way through the mass. As infants, up to the age of seven months, hardly secrete any saliva, when they are crammed with corn flour or other farinaceous food, it means that they are being fed on a substance which they cannot digest. The nurse sometimes tries to help it by putting the food first into her own mouth. The consequence of this improper diet is seen in the high death rate of infants.

The so-called farinaceous foods for infants are usually only flour baked to a light brown colour, and sweetened with sugar. The high temperature ruptures the starch granules, and converts some of the starch into a soluble substance called dextrin. The digestibility of tops and bottoms of loaves is also due to the higher heat rendering the outside more friable, and converting starch, in part, into dextrin. Those are all good for children above seven months of age.

SALTS.—You are all aware how necessary common salt is to promote digestion. You may have read how wild animals are caught by placing a piece of rock salt on the ground; the animals soon come up to lick it, and while doing so are captured. Some of you may remember that in Dr Livingstone's account of his travels in Africa, he came to a district where salt was not to be found, and the diet was purely vegetable, and you will recollect that he used to dream of roasts of beef and bowls of milk, because these matters are rich in salts, and people living on them have less need of salts than those living on a purely vegetable diet. Fresh vegetables, and notably potatoes, contain salts, which are necessary to prevent scurvy, and when persons are deprived of fresh vegetables for some time, as on sea voyages, rations of lime-juice are needed to keep up the health.

BALANCE.—It is necessary that all these elements—albuminates, fats, carbo-hydrates, salts, and water—should be present in certain proportions; that there should be a certain balance between the quantities in which they exist. In fact, where this balance is neglected, you may have indigestion in poor people from excessive eating. People who cannot afford to buy enough food may suffer indigestion from over-eating; and so it is with rich people who eat some of these constituents to excess in unbalanced food, the result, in another way, being dyspepsia. There is no single article of diet which is perfectly balanced except milk, and this only for growing young people. For old people it contains too much nitrogen, but for young people it contains the exact proportions of the different elements they require. Eggs, perhaps, come next to milk in their approach to a well-balanced diet. The heat-giving elements and salts are perhaps slightly deficient in the egg; warmth being supplied to the growing chick by the body of the incubating fowl, and salts by the gradual solution of the shell. Where people have to live upon an unbalanced food, the quantities that they require to eat in attempting to get the balance are enormous. In reading accounts of sport in America and Africa, you will notice two circumstances—first, the prodigious quantities eaten by the huntsmen when living upon flesh alone; and, second, their continual craving for fat, and rejoicing over fat meat. Dr Rae tells us that he allowed a ration to his men of 8 lbs. in the Arctic exploration, and other accounts are equally astounding. Sir John Ross states that the daily ration of natives of the Arctic regions is 20 lbs. of flesh and blubber. In many of the books in which you read such statements, you find it remarked that it is necessary to eat so largely in order to counteract the cold; but you find that in Africa, where the heat is intense, the same excessive quantities are consumed by people who live upon meat alone. Barrow tells that ten natives ate an ox all but the hind legs in three days, and three Bosjesmen attendants devoured a sheep in less than twenty-four hours; but, however, if we want really to know what a good flesh eater can do, undoubtedly we must go to the Arctic regions. There is something in the cold after all. The Russian Admiral Saritcheff heard of a person who was a great eater, and sent for him in order to give him breakfast. It unfortunately happened that he had already breakfasted, but, nevertheless, the Admiral set him down to a porridge made of rice and butter—3 lbs. of butter and the remainder of rice, 28 lbs. in all,—and he finished it at one sitting. Biscuits are a luxury to people living on a purely meat diet, for a small quantity gives rest to the weary stomach, toiling under the great load of lean meat which must be eaten to obtain the amount of fat required in the absence of vegetables or other carbonaceous food. Now, what proportion is necessary for subsistence? Here are tables in which you find the proportions of the different constituents for subsistence:—Albumenoids, 2½ oz.; Fats, 1 oz.; Carbo-hydrates, 12 oz.; and Salts, ½ oz.—making 1 lb., or 16 oz. in all, of water-free food.

100 PRISONERS EXCRETE DAILY 71½ lbs. CARBON, AND 4¼ lbs. OF NITROGEN.

To replace this loss—

If they were fed on Bread alone, would need—
380½ lbs. Bread, which contains
4¼ lbs. of Nitrogen, and 128½ lbs. of Carbon.
(Excess of Carbon wasted, 57 lbs.)

If fed on Meat alone, they would need—
354 lbs. Lean Meat, which contains
109¼ lbs. of Nitrogen, and 71½ lbs. of Carbon.
(Excess of Nitrogen, 105 lbs.)

If fed on a Mixed Diet, 256 lbs. would suffice—

200 lbs. Bread contains	60 of Carbon	— 2 of Nitrogen.
60 lbs. Meat (including 12½ lbs. of fat upon it),	12 „	— 2¼ „
	72 „	— 4¼ „

(No Excess or Waste.)

For Hard Labour (raising 10 stone to a height of 10,000 ft.)
ADD
117 lbs. of Bread, or its equivalent, to one of the above Diets.

—*Arranged from* CHAMBERS.

The foregoing shows how very expensive an unbalanced diet may be, as the excess of carbon or of nitrogen is of no use, and is thrown away; indeed, it is worse than useless, for the matter in excess is largely digested and absorbed, and can then only be excreted from the blood by the lungs, skin, or kidneys, which are embarrassed, and liable to injury by it. On the other hand, if not absorbed, it may partially decompose and give rise to illness. In the food of rich people there is generally an excess of nitrogen taken in the form of too much flesh, and the result is gouty diseases; while a diet containing too much carbon, as rice, potatoes, malt liquors, and fat, is more frequently used by the poorer classes, and checks nutrition of muscle, rendering them incapable of prolonged exertion. The body is apt to become stout, the wind short, and the mind inactive. We see the effects of such a diet exhibited in animals in menageries, which frequently die from a diet too carbonaceous. Poor people, by adopting vegetables, which are rich in nitrogen, and combining them with those that are rich in carbon, may get a fair combination without the use of meat. Peas and beans, for instance, are even richer in nitrogen than is meat, while oatmeal combines a large amount of nitrogenous with carbo-hydrate substances. Strasbourg geese show the effect of a purposely unbalanced diet. They are denied exercise, and fed upon a carbonaceous diet in a warm room, until the liver becomes enlarged to the size of that of a man. The geese are then killed, and the livers made into the famous *pâtes.*

The famous Mr Banting reduced his weight in one year from 202 lbs. to 156 lbs., and brought down his girth 12¼ inches, by avoiding food containing sugary and starchy substances, and living chiefly upon meat and other things rich in albuminates.

DIET requires to be modified in accordance with work. A diet which suffices for health during idleness will not suffice under stress of labour. Take the case of the 100 prisoners referred to in the table. If made to perform work on the diet sufficient for quietude, cases of illness, and probably deaths, would very soon occur; and to enable them to do work such as lifting 10 stone

10,000 feet, would require an addition to the diet of 117 lbs. of bread, or its equivalent. A person brought to bare existence diet can undergo no toil, bodily or mental, under the penalty of breaking down.

The proportions necessary for different conditions are seen in the following tables:—

The Average Daily Diet of Men in Quietude.

Albuminates,	2·5	ounces.
Fats,	1·0	"
Carbo-hydrates,	12·0	"
Salts,	0·5	"
Total water-free food,	16·0	ounces.

Amount of Ounces (Avoir.) and Tenths of Ounces for Male Adults.—(Playfair.)

	Subsistence Diet—*i.e.*, sufficient for the mechanical force necessary to carry on the internal work of the body.	Diet in quietude.	Adults in full health, but with easy work.	Adults in active work.	Adults in laborious work.
Nitrogenous Substances,	2·0	2·5	4·02	5·5	6·5
Fat,	0·5	1·0	1·04	2·5	2·5
Starch,	12·0	12·0	18·07	20·0	20·0
Mineral Matters,	0·5	0·5	0·71	0·9	...
Carbon (total),	6·7	7·4	11·16	13·7	14·3

Diet of a Man of 10 to 12 Stone weight, in Moderate Work.

Albuminates,	4·587	ounces.
Fats,	2·964	"
Carbo-hydrates,	14·257	"
Salts,	1·058	"
Total water-free food,	22·866	say 23 ounces.

For laborious work, such as that of the soldier on service, even more is required:—

Albuminates, - - - - -	6·0	to	7·0	ounces.
Fats, - - - - -	3·5	to	4·5	„
Carbo-hydrates, - - - -	16·0	to	18·0	„
Salts, - - - - -	1·2	to	1·5	„
Total water-free food, - -	26·7	to	31·0	ounces.

For harder work than this 35 to 40 ounces of water-free food is needed, or as much as the man can possibly eat, for then it really becomes a race between the stomach and the muscles, and foods like meat, which are rapidly digested and concentrated, become important. The quantity of water required also goes up. We have gained this information by means of very costly national experiments. In the last Arctic Expedition the men were allowed a diet of about 35 ounces, and yet that was not enough for the work to be performed. Estimates of the daily work they accomplished vary from 534 tons lifted one foot to 1000 tons lifted one foot, and the estimated value of the diet was 585 foot tons.

Sir Robert Christison said of the British army in the Crimea, that any person could have foretold as a certain consequence, sooner or later, of their dietary, that the British troops would fall into the calamitous state of health which befell them in the Crimea, the reason being, that they were sent on a diet on which they were living at home doing nothing, into a cold climate, where they had to work very hard indeed; and it cost the country a great many lives and money before the diet was corrected.

In some prisons the work and diet are so exactly balanced that the prisoners lose weight in winter and gain weight in summer. This shows that somewhat more food is required in cold than in warm weather.

Dr Frankland, of London, has experimented upon different kinds of diet as to their force-giving power, and you will see that at the head of the whole list there stands oatmeal.

Weight and Cost of Various Articles of Diet required to Raise a Man (140 lbs.) to the Height of 10,000 Feet.—(Frankland.)

	Price per ℔.		Ozs. required.	Cost.	
	s.	d.		s.	d.
Oatmeal,	0	2¾	20·5	0	3½
Flour,	0	2¾	21·0	0	3¾
Peameal,	0	3¼	21·4	0	4½
Bread,	0	2	37·5	0	4¾
Potatoes,	0	1	81·1	0	5¼
Rice,	0	4	21·5	0	5½
Beef-fat, or Dripping,	0	10	8·9	0	5½
Cheshire Cheese,	0	10	18·5	0	11½
Cabbage,	0	1	192·3	1	0¼
Butter,	1	6	11·1	1	0½
Hard Boiled Eggs,	0	6½	35·3	1	2½
Lump Sugar,	0	6	24·1	1	3
Milk (per quart),	0	5	128·3	1	3½
Lean Beef,	1	0	56·5	3	6½

The smallest quantity is required for doing the work, and at the same time it is the cheapest in price, 2¾d. per lb. We would require 20½ oz., the total cost being 3½d. It is very closely run by wheat flour, which costs ¼d. more, and ½ oz. more of it would be required. Potatoes are very low, and are expensive when you come to measure the work. 5¼d. worth is needed to do the work that is done by 3½d. worth of oatmeal. The quantity of cabbage required is absolutely ridiculous. A man, to do the work, would require to eat about a stone of cabbage, and who is sufficient for that? Of course it must be understood that this table merely gives the theoretical quantities that would produce the force. It is obviously impossible to digest a stone of cabbage, or five pounds of potatoes in addition to subsistence diet, nor would it be healthy to take large amounts of unbalanced food. Oatmeal and wheat flour have the advantage of being nearly balanced, and with the addition of milk, it would be possible to live on either of them for long periods of hard work.

Great political facts sometimes depend upon dietetics. I heard a celebrated politician and chemist once state that the greatest blessing that ever befell Ireland was the potato famine, and he explained it in this way. He said, that a diet of potatoes was sufficient to keep life going in idleness, but a man was not capable of digesting such an additional quantity as would enable him to work, and consequently Irishmen, by the very fact of this diet, were compelled to live in idleness. Maize and Indian meal have an advantage over oatmeal in containing more fat. Indian meal has 8 per cent of fat, while oatmeal only contains 6, and ryemeal 2—a fact worth remembering, though maize does require considerable cooking.

Life can be supported by a very minute quantity of food as long as complete inactivity of body is maintained, but under such circumstances the slightest exertion will bring on a fatal result. With vegetable food so cheap as it is in the shape of oatmeal, peas, etc., few people need live upon a bare subsistence diet. Two years ago I was informed that the prisoners in Stafford Gaol had the lowest sick rate and death rate in the country, and yet they were fed on 4½d. per day. Dr Parkes kept a strong soldier doing hard work in perfect health on 1¾ lb. oatmeal and 2 pints of milk daily, at a cost of 5d. for the meal, and 4d. for the milk.

Activity is the natural condition of the young, and they bear starvation much worse than old people. The younger they are the more easily they are starved. Milk is essential to the proper nutrition of the young. Dr Ferguson, the Factory Inspector, by a careful continuous measurement of factory children, found that between thirteen and sixteen years of age they grew four times as fast on milk for breakfast and supper as on tea and coffee.

The excellent and time-honoured porridge of Scotland does not agree with some persons (young and old). When this is the case, it may often be corrected by longer cooking, or by mixing wheat or barley meal with the oatmeal. If it cannot be taken in any form, bread and milk is the best substitute. Young people should have four or five abundant meals per day, of plain food, without stimulants or spices. Strong tea, ham and smoked articles, are not advisable; nor should food be given to children too hot, as this frequently damages their teeth, and it is necessary to preserve the teeth as long as possible, as aids to digestion. The value of the teeth is not understood till they are lost, and then it is too late. They should never be extracted if the dentist can fill them; and as a common cause of decay is the fermentation of food lying between them, frequent washing and brushing of the teeth is a means of preserving them.

To keep old people in health the diet should be spare, but very digestible, and easy of solution. Their toothless jaws and feeble digestive organs fail to extract nourishment from food that would be very well suited to younger persons.

A word as to the time when food should be taken. For working people who have to do hard manual labour, it is undoubtedly best that some food should be taken before beginning work. Unless the blood contains the means for supplying force, the work is done at the expense of the body. Consequently, when it is possible, the greater portion of the day's food should be taken at breakfast and early dinner. One authority states that 1½ parts of the day's food should be taken at breakfast, two at an early dinner, and one part at the evening meal. No doubt work immediately after a meal interferes with digestion, but this only applies to very hard work, and there is usually an interval of rest. Though children require food often, it is found that digestion proceeds better in the case of grown-up people when they take three, or, for some people, two meals a-day.

COOKING.—By cooking, we prepare our food for digestion, and by it a large amount of vegetable food is placed at the service of man which are quite useless to him in the raw state. 'It is, moreover, chiefly by the same art that he has been enabled to take his food at intervals, in separate meals, and has thereby been for ever relieved of the necessity which is imposed on all animals in the wild state of having to spend almost the entire of their waking hours either in seeking after their food, like the carnivora, or in consuming their food like the vegetable feeders.'

Cooking has a mechanical action by which it ruptures starch cells, disintegrates fibres, and softens the whole food, which is then easily acted on by the digestive fluids. In addition to this mechanical effect, cooking produces chemical changes of an important kind, as facilitating digestion. Prolonged cooking causes changes in the food which approach very closely to, if they are not identical with, the alterations effected by the action of the digestive fluids themselves; and thus, by the use of fire heat, man is saved a great amount of labour which falls upon the digestive organs of the lower animals.

Another object of cooking is to provide the variety which is so desirable and, indeed, necessary for young people. Even when the food cannot be varied, it is at all events often possible to change the method of cooking it. A varied diet is more digestible and healthier than a monotonous one. While studying variety, it is well to remember that the diet should not be restricted to substances which can be entirely digested and absorbed, but that it is better to have a certain amount of insoluble non-irritating residuum to give bulk, and promote the movements of the alimentary canal. Brown bread should be frequently used as a change from white, but if too coarse the residuum is irritating, and hurries the food along the alimentary canal without giving sufficient time for digestion and absorption. Most vegetables yield a considerable amount of residual matter, and hence a diet abounding in vegetable food, and especially when it contains some of the outer covering of the grain, is used in constipation.

Still another office of cooking is to balance our food, and it is perfectly wonderful how correct popular instinct is in the combinations which it has effected. For instance, animal and vegetable food are taken together; salad with salt meat. Bread, which is deficient in fat, is eaten with butter; bacon with greens, pork with peas-pudding. Peas contain 22 per cent of nitrogenous material, while bacon contains next to none. Peas are poor in fat, having only two per cent, while bacon has 70 per cent; so that by combining the two the excess of the one balances the deficiencies of the other.

Thorough cooking destroys parasites in the food, which might give tape-worm or other diseases to man; and for this reason, as well as to increase digestibility, meat, especially the meat of the pig, either fresh or as ham, should be completely cooked.

The mode of cooking has such an effect upon the digestibility of the same substance, that it is rather difficult to form a table of precedence in this respect. Two of the following tables are derived from the experiments of Dr Beaumont, who took into his service Alexis St Martin, a Canadian, who at the age of 19 had an opening made into his stomach by the discharge of a gun, and yet lived with the opening unclosed long enough to become the father of a large family, and to allow Dr Beaumont to make many observations on the interior of the stomach, and the effects on food introduced through the opening. Other cases of a similar kind have afforded opportunities to more recent experimenters, and hence the table by Dr Chambers is inserted.

RELATIVE DIGESTIBILITY OF VEGETABLE SUBSTANCES.

Articles of Diet.	How Prepared.	Time of Chemification.	
		H.	M.
Rice, - - - - - -	Boiled,	1	0
Apples (sweet and mellow), - -	Raw,	1	30
Sago, - - - - - -	Boiled,	1	45
Tapioca, - - - - -	Boiled,	2	0
Barley, - - - - -	Boiled,	2	0
Apples (sour and mellow), - -	Raw,	2	0
Cabbage with vinegar, - - -	Raw,	2	0
Beans, - - - - - -	Boiled,	2	30
Sponge Cake, - - - -	Baked,	2	30
Parsnips, - - - - -	Boiled,	2	30
Potatoes, - - - - -	Roasted,	2	30
Potatoes, - - - - -	Baked,	2	33
Apple Dumpling, - - - -	Boiled,	3	0
Indian Corn Cake, - - -	Baked,	3	0
Indian Corn Bread, - - -	Baked,	3	15
Carrot, - - - - -	Boiled,	3	15
Wheaten Bread, - - - -	Baked,	3	30
Potatoes, - - - - -	Boiled,	3	30
Turnips, - - - - -	Boiled,	3	30
Beets, - - - - - -	Boiled,	3	45
Cabbage, - - - - -	Boiled,	4	0

RELATIVE DIGESTIBILITY OF ANIMAL SUBSTANCES.

Articles of Diet.	How Cooked.	Time of Chemification H.	M.
Pigs' Feet (soused),	Boiled,	1	0
Tripe (soused),	Boiled,	1	0
Eggs (whipped),	Raw,	1	30
Salmon Trout,	Boiled,	1	30
Venison Steak,	Broiled,	1	30
Brains,	Boiled,	1	45
Ox Liver,	Broiled,	2	0
Cod-fish (cured dry),	Boiled,	2	0
Eggs,	Roasted,	2	15
Turkey,	Boiled,	2	25
Gelatine,	Boiled,	2	30
Goose,	Roasted,	2	30
Pig (Sucking),	Roasted,	2	30
Lamb,	Broiled,	2	30
Chicken,	Fricasseed,	2	45
Beef,	Boiled,	2	45
Beef,	Roasted,	3	0
Mutton,	Boiled,	3	0
Mutton,	Roasted,	3	15
Oysters,	Stewed,	3	30
Cheese,	Raw,	3	30
Eggs,	Hard Boiled,	3	30
Eggs,	Fried,	3	30
Beef,	Fried,	4	0
Fowls,	Boiled,	4	0
Fowls,	Roasted,	4	0
Ducks,	Roasted,	4	0
Cartilage,	Boiled,	4	15
Pork,	Roasted,	5	15
Tendon,	Boiled,	5	30

You will observe that tripe was digested in one hour, and this explains why tripe is a favourite supper dish, as it enables the process of digestion to be finished before going to sleep. Salting meat spoils it very much. The soluble valuable parts are abstracted, and the remainder rendered hard and indigestible.

Table of Precedence in Digestibility of some Articles of Animal Food.—(Chambers.)

Sweetbread and Lambs' Trotters.
Boiled Chicken.
Venison.
Lightly Boiled Eggs, New Toasted Cheese.
Roast Fowl, Turkey, Partridge, and Pheasant.
Lamb, Wild Duck.
Oysters, Periwinkles.
Omelette (?), Tripe (?).
Boiled Sole, Haddock, Skate, Trout, Perch.
Tripe and Chitterlings.
Mutton.
Roast Beef.
Boiled Beef.
Rump Steak.
Roast Veal.
Boiled Veal, Rabbit.
Salmon, Mackerel, Herring, Pilchard, Sprat.
Hard Boiled and Fried Eggs.
Wood Pigeon, Hare.
Tame Pigeon, Tame Duck, Goose.
Fried Fish.
Roast and Boiled Pork.
Heart, Liver, Lights, Milt, and Kidneys of Ox, Swine, and Sheep.
Lobsters, Shrimps, Prawns.
Caviare.
Smoked, Dried, Salt, and Pickled Fish.
Crab.
Ripe Old Cheese.

In some of the numerous treatises on health being at present published, and many of which are very expensive in the end, as they take up only a single subject and pad it out to the shilling size, you will find it stated that it is a mistake to take soup before dinner, as it dilutes the gastric juice.* This is incorrect, for two reasons—firstly, because there is no gastric juice to dilute until the secretion is provoked by food; and, secondly, because the soup furnishes to the blood the elements for the formation of the gastric juice that is to digest the food. During fasting the blood is poor in the materials for the formation of gastric juice, and if boiled white of egg be introduced into the stomach of a fasting dog it lies undigested for a long time, owing to want of gastric juice. Hence the practice of taking soluble nitrogenous nourishment, such as soup, before dinner, is an excellent one in view of preparing the stomach for what is to follow. To the general statement that food is rendered more digestible by cooking there are a few exceptions. The digestibility of milk is unaffected by boiling, but it is otherwise with the oyster. 'The oyster is almost the only animal substance which we eat habitually, and by preference in the raw or uncooked state; and it is interesting to know that there is sound physiological reason at the bottom of this preference. The fawn-coloured mass which constitutes the dainty of the oyster is its liver, and this is little else than a heap of glycogen. Associated with the glycogen, but withheld from actual contact with it during life, is its appropriate digestive ferment—the hepatic diastase. The mere crushing of the dainty between the teeth brings these two bodies together, and the glycogen is at once digested without other help by its own diastase. The oyster in the uncooked state, or merely warmed, is, in fact, self-digestive. But the advantage of this provision is wholly lost by cooking, for the heat employed immediately destroys the associated ferment, and a cooked oyster has to be digested, like any other food, by the eater's own digestive powers.'

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* The best manual of this kind, and one that I heartily recommend, is 'Personal Care of Health,' by the late Dr Parkes. Published by Society for Promoting Christian Knowledge. Price 10d.

VEGETARIANISM.*—Man can live upon a purely animal or upon a purely vegetable diet, but my judgment is that he can live best upon a mixture of both. When economy has to be studied he should be almost entirely vegetarian, and without doubt many people would enjoy better health if they practised economy in this way. The only obstacle is unfortunately the formidable one, that vegetable food requires a little more time and care in cooking to make it eatable than flesh does, and that to vary a vegetable diet would involve a trifling mental effort, while forethought appears to be abhorrent to those who most require it. Vegetarianism as practised by most so-called vegetarians, involves the large use of milk and eggs.* London needle-women were found to be starving upon tea, bread, and bacon, costing 2s. 7d. per week, while Irish labourers were well fed on potatoes, milk, and maize, at a cost of 1s. 9¾d. per week.

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* Mr Clark of the Vegetarian Depot, Greenside Row, has sent me a number of vegetarian publications which I have read, and having procured and tried some of the cereal preparations recommended, I can say that the foods are infinitely better than the arguments for their use.

Under the head of Drink, I shall not take up Water, which is to form the subject of a separate lecture, but pass at once to say something about stimulants. Depression may arise from bad air or from over-fatigue, or from ill health. Bad air is to be remedied by ventilation, and for bad health a physician should be consulted. Alcoholic stimulants are the worst we can select, speaking generally, for the effects pass off with great rapidity, and leave the depression worse than before. There is no doubt that alcoholic liquors should be abjured by growing people except under medical advice, and for grown-up people the only time that they cannot be proved to do marked harm is when taken largely diluted, along with food, after the day's work is done.

I may refer you to experiments carried on by the late Dr Parkes, at Netley Hospital. He selected three men to be experimented upon—Sergeant-Major Don, Private P. Holz, and Private W. Hutchins. These men volunteered to undergo experiments for a week, in the shape of marches in heavy marching order, carrying a total weight, including the clothes on their persons, of 51 lbs. Dr Parkes states that, 'having breakfasted at six o'clock, they started at seven, and marched 13¼ miles without a halt or refreshment of any kind. This march was accomplished in 4 hours and 20 minutes. After resting for an hour, during which their pulses and temperatures were taken, they received either rum, or extract of meat, or coffee, with, in each case, ten fluid ounces of water. They then marched 4¼ miles, making 17½ in all, and then, after another halt, had a second allowance of the same substance, with the same quantity of water. A march of 3 miles was then made, making 20½ miles. The rate of march was 3·2 miles per hour; the time taken was 8½ hours, of which two were occupied with halts. At the end of the last march the men had their dinner.

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* See 'Food Reform Association's Cookery Book,' by Tarrant: worth buying. Price 2d.

The rations were the usual rations, and the same amount of food was taken daily. The marches were continued for six days, so that each man received rum on two days (but not on successive days), meat extract on two days, and coffee on two days.' This was very hard work; so very hard was it, that when they came in on the first day one of them fainted, and Sergeant-Major Don was in such distress that he was warned not to go on with the experiment, but they all persevered to the end of the six days. At the end of the experiments the men were asked to state their candid opinion of the relative value of the three substances during marching, and Sergeant-Major Don said,—'The meat extract is the best to march on, more strength is given by it; about this I have not the slightest doubt. After the extract I prefer the coffee, and I put the rum last for marching.' Private Holz said,—'I prefer the meat extract; it gave me more strength. As regards the coffee, I would put it before the rum, as the effect of the rum went off in two miles, and I felt better after the coffee than after the rum.' Private Hutchins said,—'I prefer the meat extract; it certainly gave me more strength for marching; it does not put a spurt into you for a few miles, but has a lasting effect. . . . I prefer the coffee to the rum because it quenched thirst, and also the rum at the end of a couple of miles left you as bad as before, or even worse, while the coffee had no effect of that kind.' Private Hutchins said also, that after taking his rum he felt as if he could have jumped a five-barred gate, but that at the end of a mile and a-half his feet were dragging like lead.

Tea and coffee are excellent stimulants, and the former, when not exposed to the air too long, contains a volatile oil very stimulating indeed. Tea along with meat is not a good mixture, because the tannin contained in it interferes with the digestion of albumenoid food.

Through the kindness of the Secretary of the United Kingdom and Provident Assurance Company, I am able to provide you with some extraordinary statistics. In that Society there are about 10,000 teetotalers insured, and there are about 20,000 general insurers. Perhaps you know how exceedingly careful Insurance

Companies are about taking persons addicted to excess of drink. They know that it would not pay, and so their medical men and directors are very strict about it. They reject persons who take alcohol in the forenoon, on the ground that if it is by medical advice, they must be too ill for their life to be assurable, and that if it is not by medical advice, they will very soon be too ill to suit the Insurance Company. In this Society to which I have referred it was found in 12 years, that among the teetotalers and the general section, which are kept separate, there was a very marked difference as to the mortality. In the general section it was expected, according to the table, that 2846 persons would die, and you will see how accurate that table is when I state that 2807 did die. The secretary, in his calculations, was on the safe side by 1·4 per cent. Now as to the teetotalers it was expected that 1619 would die, but instead of that there did die 1156, so that in this case he was 463 wrong. In the one case 1·4 per cent did not die, and in the other case the teetotalers refused to die to the extent of 28·5 per cent. In comparing the two classes, however, we must remember that those in the general section are not drunkards, and that the general community who are accepted by the Insurance Offices are not those most likely to take to drink, and include some who are teetotalers in all but the name. I believe a good deal in the poisonous effects of alcohol, but I am not able to credit it with all of this astonishing difference. The explanation, which is satisfactory to my mind, is, that strong and healthy people, likely to live long, are more apt to become teetotalers than those in weaker health. The former feel that they have no need of stimulants, and that it is no sacrifice to take the pledge; the latter feel the need of them, and decline; and so by a process of self-selection the strong man goes to the one side, and the weaker man to the other.

Taking them all in all, soldiers are not teetotalers, but they seem to do better without stimulants. As confirmatory evidence of the good health of teetotalers, I may refer to the Ashantee war. The climate was exceedingly bad, and four out of every six of the soldiers went through the hospital, but of teetotalers only one out of every six went through it. There are two commanders just now, Sir Garnet Wolsley and Sir Frederick Roberts, neither of whom believe in the issue of a rum ration to the troops. Sir Garnet will not allow it, for the very practical reason, that the army when it is not allowed a ration of spirits will allow itself to be knocked about in any way, and will not grumble, but if allowed a ration of rum the men find every additional duty a grievance, and grumble excessively. In the Red River Expedition in Canada, in which Sir Garnet won his fame, he did not allow them to carry stimulants, and although they performed some extraordinary work, yet the health of the troops was so good, that if it had not been for a few broken bones they might have left the doctors at home. In South Africa it was the same. Where they could not get stimulants they were healthy, and did not enter the hospital, but whenever they came into a land flowing with rum, then they entered the hospital freely.

But people must have some drink, and if rum or beer be not the thing, what is the thing? I believe there is nothing better than a thin gruel, made of well boiled oatmeal, with a little sugar in it, and I state that upon the authority of Dr Parkes and of some eminent railway engineers. I shall take one case, in which a broad gauge railway was being changed into the narrow gauge. To avoid any long interruption of traffic it was desirable to have this change effected as rapidly as possible, and 314 men were put on to the work, which they finished in four days, working almost night and day, and it was then found that this thin oatmeal gruel was the drink that was most successful. The Engineer of the Varna railway, who writes a book on Turkey, mentions, that to encourage the men, who were clearing away a block of snow on the line, he gave them spirits, but found that they knocked up in about a quarter of an hour afterwards, and he then made the discovery that, for continuous work, some other stimulant was necessary. The proportions of the gruel I have mentioned are—¼ lb. of oatmeal in three or four quarts of water, with an ounce of sugar, and well boiled. I recommend this to you, as a good means of quenching thirst, and permitting work to go on.

APPENDIX

CONTAINING

THE PRINCIPAL PRACTICAL POINTS.

Economy.—Flesh meat is expensive, and perfect health may be maintained, and hard work can be done, without it. Taken, however, *once* a day, it forms an agreeable variety, and cannot be said to do harm. Oatmeal, wheat flour, peameal, maize or Indian corn, and many others, supply the place of meat. With these, and rice, milk, potatoes, butter, fat, or oil, and fresh vegetables or fruits, people may be well nourished at small cost. When hard work has to be done with extreme economy nothing equals cooked oatmeal with milk.

Variety.—The material of the principal dish at dinner should be changed often, or it should be cooked in a different way. Monotony in diet is to be avoided, especially for young people.

Eating.—Some food should be taken before work; and the bulk of the day's food taken at breakfast and mid-day dinner, to sustain the body during work; tea dinners are not a good plan. Eat slowly, and chew well, if you wish to live long and escape indigestion and low spirits. *Violent* exercise immediately after food should be avoided. Regularity as to time and quantity is important.

Cooking.—More skill and trouble are required for cooking vegetable food than animal food, for flesh is more nutritious if eaten raw than when cooked, but less digestible. Flesh, and especially pork or ham, should be cooked through and through, to avoid risk of tape-worm and other parasites. Overcooking is apt to spoil animal food, and undercooking most frequently spoils vegetables. Cook slowly.

DRINK.—By far the best drink for heavy work is a quarter of a pound of oatmeal, well boiled in two or three quarts of water, with an ounce or an ounce and a-half of sugar added. Beer or alcoholic drinks should be altogether avoided by growing persons, and should only be taken in a diluted form, with food, after the day's work is done. Even in the case of grown-up people, it is found that teetotalers, as a rule, live longer than moderate drinkers.

STIMULANTS. - The best stimulant of a ready kind for fatigue is Liebig's Essence of Beef, strong coffee or strong tea comes next to it. Spirits cannot be used if work has still to be done or cold endured, as they merely give a temporary spurt, and the fatigue and depression are then worse than before.

YOUTH.—The meals should be four or five in the day. The food should be abundant but plain, and without stimulants or spices. Tea, ham and smoked food, are not good. Factory children between thirteen and sixteen years of age were found to grow *four times as fast* on milk for breakfast and supper as on tea and coffee. Food and drink are frequently given to children too hot, and this damages their teeth.

ADULT LIFE.—About twice as much food is required for *very* hard work as for complete idleness, and about once-and-a-half as much for ordinary work. Three meals a-day, and for some people two, are enough. For spurts of exceedingly severe work, during which it is necessary to eat as much as can be digested, it is desirable that the diet should contain a large amount of meat.

OLD AGE.—The food for old age must be very digestible, but should be small in quantity. Very old people are always spare in their diet.

A FEW WORDS ON LUNGS AND AIR.

By Dr. ANDREW WILSON.

On the evening of Saturday, 4th December, Dr. Andrew Wilson delivered the third of the course of Health Lectures in the Free Assembly Hall, his subject being, "A Few Words on Lungs and Air." Dr. Wilson said :—

Ladies and Gentlemen,—Most of you, I doubt not, are familiar with that incomparable allegory of Addison's, entitled the "Vision of Mirza," who, led by his guide, looks eastward to a great valley through which flows a rapid tide. The valley, his guide informs him, is the Vale of Misery, and the tide of water forms part of that great tide of Eternity which is called Time. Across this shoreless ocean passes a lengthy bridge. At either end the bridge is cloaked in sombre shadow, and the bridge, Mirza is informed, is meant to typify human life. The bridge contains threescore and ten arches, but at its far end, are several arches incomplete and broken. Multitudes throng the bridge, and Mirza is horrified to find that as they pass on their way across its arches, the passengers now and then disappear mysteriously from sight, and fall through trap-doors which lie in the line of their path. The most frequent pitfalls are at the beginning of the bridge and at its end; there are fewer pitfalls in the middle. The parable is one, as you know, of human life. The pitfalls, which are most numerous in the beginning of the bridge of life, represent the diseases or chances of death to which infancy is most subject; and it is natural that towards the close of existence the pitfalls should also again become multiplied. Many important practical lessons may be derived from Addison's allegory, and especially certain lessons that are intimately connected with the subject upon which I have now the honour of addressing you. The lesson which I think comes very prominently before us, and is taught by a physiological review of the allegory of Mirza is, that while the pitfalls in life's pathway are very numerous, yet science is competent to lessen their number; and I shall try to show you in to-night's lecture that these pitfalls may be lessened by attention to one aspect of life—namely, that which concerns the work of the lungs. There are four important questions which we must consider—firstly, Why we breathe; secondly, How we breathe; thirdly What we breathe; and fourthly, How we may breathe properly. If, therefore, we can satisfactorily answer, in a plain and homely fashion, these four questions, I think we may congratulate ourselves at the close of our task on obtaining a certain amount of information which bears in a very important fashion upon the preservation of health and the prolonging of life.

The first of our four questions is, I think, readily answered. Perhaps, however, you will permit me to say, in no deprecatory spirit, that there exists a complete and wholesale ignorance regarding the subject of breathing. Why our chests should rise and fall sixteen or seventeen times a-minute, is a complete mystery even to persons of culture. That the mere movements of the chest are repeated with singular regularity, that under the influence of emotion they are quickened somewhat, and that they are essential and necessary to life's continuance, we all know; but such information yet leaves unexplained the meaning of the breathing process. If the question were succinctly asked, I repeat, 'Why does the chest rise and fall so regularly?' perhaps no satisfactory answer might be forthcoming. A little reasoning might certainly suggest that air from the atmosphere was inhaled, and that air was likewise given out. But as to the difference between the air which passes into the chest and that which comes out from it; as to the very existence of any difference at all; as to the purpose of the air passing into the chest; or further, as to the reasons for the differences between the air going in and coming out, popular philosophy must own itself to be, as a rule, entirely ignorant. Let us, therefore, try to answer fully the question, Why do we breathe? Suppose you had a person shut up in the proverbial glass box which is supposed to be a proper fate for certain individuals whom we number among our friends and acquaintances, I presume you will admit that that person must breathe, and must likewise have food. I choose this example because a person shut up in the metaphorical glass box would live apart from all the trouble and anxieties of life, and his body would apparently be completely at rest. His chest, however, would still rise and fall, and you would therefore have to provide him with air, and also with food and drink. What, therefore, is the meaning of Nature's demands, seeing the man is not engaged in his ordinary work, and seeing that he is removed from all the outer cares of the world? A little reflection shows us that the man's body, although in a state of rest, is still working. You cannot stop the beating of the heart, by which blood is propelled through the body. You cannot stop the man from thinking; and therefore, arising from the work of heart and the work of the brain, you will have waste, or wear and tear, which requires to be repaired. We repair that waste by the taking in of matter from the outer world, which matter we term *food.*

Let me ask your attention for a moment to this question of waste; for that is the special point that concerns us at the present time. No living being can even exist or perform the simplest vital acts without entailing waste. You cannot lift an eyelid, you cannot move a finger, your heart cannot beat a single stroke, or your brain think a single thought, without the organ which works in each case exhibiting waste proportionate to its work. If it works much, it wastes much; if it works little, it wastes little. Now, the lungs form one of three organs devoted to the getting rid of these waste matters. These organs are the lungs, skin, and kidneys. One organ is capable to a certain extent of taking on the work of the other, when the latter is injured by disease. Thus, a person suffering from inflammation of the lungs will be treated by the administration of medicines, causing an intense action of the skin,—and why so? The answer is, because physiology has taught the physician that the skin performs much the same kind of work as the lungs, and that the skin may to a certain extent act as a deputy to the lungs. The lungs may be said, then, to be occupied in the work of *excretion*, or that of getting rid of the natural waste of our bodies, which the work of our frames entails. Then, secondly, lungs may be viewed in another sense, namely, that they supply us with a certain amount of nourishment, namely, the *oxygen* of the air. Food may be either solid food, water, or oxygen. You have to think of the oxygen of the air as material for carrying on the processes of life, just as a beef-steak assists in the renewal of our frames. You may discern then, clearly the position of the lungs in their double relation of "givers out," and "takers in." And what I say of the lungs of man applies to the gills of a fish, mussel, oyster, lobster, or any other animal that breathes in water. Although they are popularly said to "breathe water," they in reality breathe the air that is entangled in the water, and thus may be said to breathe essentially the same air and in essentially the same fashion as man himself.

What waste matters, however, do we give out from our lungs? I think there are seven kinds of waste material into which our bodies are chemically breaking down. There is firstly, Heat. Although heat is necessary of itself for the continuance of our lives, still so much is always being dissipated from our bodies. That may be said to be the surplus of the heat which is required for carrying on the processes of life. Secondly, there is Water, which in some form or another—as watery vapour, or simply as water, is being excreted from the body. Suppose, for instance, that a number of persons are seated in a compartment of a railway carriage. They pull up the windows, in a short time the glass will become obscured by vapour, and, as these persons continue to breathe in the compartment, fluid will trickle in due time down the windows. If a chemist were to analyse that fluid he would tell you that it was pure water. It has been breathed out or "excreted" from our blood by the lungs. Thirdly, there is Carbonic-acid Gas, and of all the matters given out from our lungs, this carbonic acid stands in the first rank. Fourthly, there is Ammonia, a chemical name for a substance identical with that you familiarly call hartshorn.

Fifthly, comes Organic Matter, that is the actual waste matter of the body itself, or our actual bodily particles. There is no matter in the impure or vitiated air of our rooms, which is of more consequence as injurious to health than this organic matter. Sixthly, there is given off a small quantity of Mineral matter; and seventhly, we find amid our waste material a substance called Urea, this latter substance being chiefly given off by the kidneys. Urea is a compound which, if allowed to remain in our blood, causes death by convulsions. If these waste matters, as a whole, be allowed to accumulate in the blood, or, what is of equal importance, if they be rebreathed again or re-enter the system, the consequence may be disease, or even death itself. All three organs—lungs, skin, and kidneys, let us note, get rid of essentially the same things. There is no difference, in kind, between the work of the lungs, the work of the skin, and the work of the kidneys. These seven substances are given off by all three organs, but in different proportions. Which of the substances stand out prominently as the product which the lungs excrete? Firstly, Carbonic Acid; secondly, Watery Vapour; and in the third rank we may place Organic Matter. We have therefore these three things specially to consider in this discourse.

Now, as to the second of our four questions, How do we breathe? This point is of extreme importance; and to properly appreciate the work of the lungs, to understand what the lungs do, you must know where the lungs are. Examining the chest we find the spine or backbone behind; then come twelve pairs of ribs forming a bony cage and meeting the breast-bone in front. Then we have also got a very important muscle called the *midriff* or *diaphragm*, which forms the floor of the chest, this floor being arched. To give you a clear conception of the relations of chest and midriff, suppose the chest to be a room or apartment, and suppose a person to be standing inside that room, then the floor (that is the diaphragm) on which he stood would be arched or curved. Our chest is not a rigid bony cage. On the contrary it is highly elastic; for where the ribs join the breast-bone you have got that elastic material called gristle or cartilage, so that the chest may expand more readily in breathing. If pressed in a crowd you would find that you are able to sustain great pressure from the front, because of this elasticity, but if you met the pressure with your sides, the chances would be that your ribs would get broken. The chest is thus elastic from the front backwards, but brittle from side to side. What is the use of this muscular diaphragm or midriff? The answer is that it is the muscle which assists us in breathing. A mere child knows you have *inspiration* or breathing in, and *expiration* or breathing out. Inspiration is the act which gives us a considerable deal of trouble, for if you will take in a deep breath, expanding your lungs to the fullest extent, you will find that while the action of breathing in gives us considerable trouble, that of breathing out is very much easier. It seems as if, when in the act of breathing in, you raised your chest to a false or unnatural position, if I might be allowed to use the expression; then, when you let the chest go in the act of breathing out, it seems to return to its natural position easily and without the least effort. How is inspiration performed? By means of the diaphragm. This great arched muscle has the power of contracting. It then grows less arched, but in so doing draws the chest downwards and also enlarges it from side to side, thus increasing the capacity of the chest. Then also there are certain little *intercostal muscles* which lie between each pair of ribs and which assist the diaphragm in the action of enlarging the chest. What then happens to the lungs? The lungs are a pair of elastic bags, having their sides closely applied to the walls of the chest. It therefore follows that when the chest walls move and when the chest enlarges, the lungs expand likewise, and air passes into the chest. When the chest may be said to return into its position of rest, the lungs contract and the air is thus expelled. The act of breathing is then easily understood, when you think of the chest as a movable case containing a pair of elastic bags or lungs which respond to the movements of the cage in which they lie.

Let us now pass to consider the structure of the lungs themselves. In gaining ideas about even complicated things, it is well if we can start with a general idea of a special subject. For instance, in teaching the physiology of the heart, what is first wanted is a good general idea of what any kind of heart is. You get such an idea by thinking to yourselves of a "hollow muscle;" for the heart is nothing more nor less than a muscle, which is, first of all, hollow to allow blood to pass through it, and which secondly, is a muscle that it may contract to propel the blood. The general idea that I want you to have of the lung in the same way, is that any lung, from that of a frog to that of a man, is simply *a bag of air-cells* or pockets containing air. Look at this diagram. In front of the throat you have a pipe called the windpipe or *trachea*, strengthened by gristly rings, and having the organ of voice or larynx at the top. This windpipe or trachea divides at the root of the neck into two branches or *bronchi*—a main-pipe for the right lung and another main-pipe for the left lung. The lungs, as you see, are two in number, and have the heart lying somewhat obliquely between them. Look at the surface of the lung. It is divided into a great number of small spaces or divisions seen very well on the outside of the lungs. These little divisions are called *lobules*. Each lobule is like all its neighbours, so that if you get an idea of the structure of one little division you understand the whole. Suppose you dissect the lung, what do you find? You find that this windpipe branches out into innumerable divisions, and imitates a tree of small tubes which grow finer and finer the further you pass away from the main divisions of the windpipe. Trace out one of these tubes to its ultimate ramifications, and you find it to end in a cluster of small bags or cells. Suppose a main passage to have a number of little rooms clustered round one end of it in a somewhat circular form, and you get an idea of the ultimate structure of the lungs. In this diagram here, you notice two clusters of things that look like bunches of grapes, and these are really two groups of the air-cells of which the lungs are composed. Let me now ask your attention to the size of these air-cells. They vary in size in different parts of the same lung, but each measures on an average about the $\frac{1}{40}$th part of an inch in diameter. Thus you find that the lung itself, though a large organ (the two lungs weighing about 40 ozs.), is made up of microscopic parts. As to the colour of the lungs, they are in infancy of a rosy pink hue. But it may be asked, Why do we specify their infantile colour? The answer to that is, that our lungs are not of the same colour throughout life. When we grow older they turn to a grey colour, and sometimes to a dark bluish grey. What is the meaning then of this change? Formerly it was believed that the lungs naturally changed colour. Now, however, we believe that they change colour owing to the substances or matters which are inhaled into them from the outside world. Men who work at trades or in places where a large number of black particles float in the atmosphere have blacker lungs than other people. Colliers, for example, suffer from a disease which is called "colliers' lung," or "black phthisis." It appears to be caused in individuals of a weakly constitution by the irritation set up by the innumerable particles of coal dust breathed into the lungs. The needle grinders of Sheffield, too, were formerly liable to suffer from a disease which got the name of "needle-grinder's lung." It was caused by particles of iron being inhaled and passing into the chest, literally cutting the lungs to pieces. That disease, however, has, I believe, been minimised in Sheffield by the use of magnetised masks which attract the particles, so that they do not pass into the lungs. Our lungs are thus very largely coloured and affected by the particles of matter we inhale. Each lung is covered by a beautifully delicate membrane called the *pleura*, and the sides of the chest are lined with the same membrane. In the movements of breathing the lung does not therefore rub against the side of the chest, but the pleura covering the lung rubs against the pleura lining the chest. A small quantity of fluid is thrown out from the pleura and lubricates the lung in its movements. When the pleura is inflamed we have the affection known as pleurisy, which thus does not, as is supposed by some, mean inflammation of the lungs themselves.

Let us now take a rapid review of the relations of heart and lungs. What do the lungs do? They get rid of waste matters, as I have already said, but we may now inquire as to the sources from which these waste matters are obtained.

I have here a diagram which represents the theory of the circulation. You observe that the pure blood coming from the lungs, passes out from the left side of the heart to nourish the body. That blood soon becomes impure. After it has nourished our body, it acquires from the tissues of the body, a large amount of waste matter. That waste matter is now passed along in the current of blood, is taken up by the veins to the right side of the heart, and thence is passed back to the lungs, there to be purified. So that the lungs are continually giving pure blood to the left side of the heart, while they are as incessantly receiving impure blood from the right side. The lungs resemble a person receiving with one hand, and giving away with the other. What changes does the blood undergo in the lungs? The blood, after passing through the lungs, changes from a dark purple to a light red colour. If we take the dark, venous, or impure blood from a living animal, we may change it into light blood by passing a stream of oxygen gas through it; or if we take the pure, arterial, or light-coloured blood and pass carbonic acid through it, it at once becomes dark-coloured. We thus see that the change in colour is due to the action of these gases. The red blood globules are the oxygen carriers of the blood, and it is in these little bodies that the changes in question take place. The blood in passing through the lungs thus gains oxygen; it loses carbonic acid; becomes 1° or 2° warmer; coagulates or clots sooner; and contains more fibrin.

Let us now inquire in the next instance, how the lungs accomplish their all-important work. We are continually breathing in oxygen, and are as continually giving out carbonic-acid gas. How is it that the exchange is managed? The lungs may be compared to a market-place, where two merchants are met to transact business, or rather to barter—blood representing one merchant, and the atmosphere the other. The blood says to the atmosphere, "If you will give me oxygen, which I require, I will give you carbonic acid." And the atmosphere, on the principle that fair exchange is no robbery, agrees to the exchange. It may be well to remind you here of the use of this carbonic-acid gas. This gas is exceedingly injurious to animals, but every green plant is greedily sucking it in by day. Carbonic acid is in fact an important constituent of the food of plants. In this fact we have an instance of that wise ordering of Nature's laws and rules whereby no waste is permitted in her dominions. What is a waste product in one kingdom is utilised for the nutrition of the other; carbonic-acid gas, useless and dangerous to the animal, becomes part of the food of the plant world. As to the manner of exchange of the two gases in the lungs, that is a matter of chemistry, or rather of natural philosophy, inasmuch as you find that where two gases of different densities are separated by a thin membrane, it is a law of Nature that they tend to change places. Thus blood containing carbonic-acid gas is brought to the lungs, and the air containing oxygen passes into the air-cells. The blood contained in the network of vessels outside these cells will part with its carbonic-acid gas, which, through the law of diffusion of gases, then passes into the lungs to be breathed out. The oxygen in its turn, passes in the reverse direction, through the thin walls of the blood-vessels and air-cells into the blood.

A word now about the amount of air necessary for a single breath, before I proceed to the topic of ventilation. Remember that by the deepest breath it is impossible to exhaust the lungs of air. The teachings of natural philosophy fully account for this fact. Suppose you had an empty space inside your chest, the chest would be in danger of being crushed in by the air from the outside. We live under an equal pressure of air from all sides. The outward air presses on the body to the extent of about 15 lbs. to the square inch. We do not feel this pressure, because it is perfectly an equal on every side. The air inside requires, for our physical safety, to press outwards, with the same pressure that the air outside is pressing inwards. The air remaining in the lungs over and above the deepest expiration is named by physiologists, *residual air.* How much residual air remains in the lungs of a man of average height after breathing out? The answer is, that it is ordinarily calculated at 100 cubic inches. What amount of air (*tidal* air) do we take into, and put out of, our lungs without any extraordinary exertion? About three-quarters of a pint, or from 20 to 30 cubic inches. You may thus be said to have in your lungs 130 cubic inches, but in a deep inspiration you draw in another 100 inches; therefore in a full breath you will take in about 230 cubic inches of air. Mr. Hutchinson of London made a number of researches in order to ascertain the *vital capacity* of the lungs. Without giving you the details through which he arrived at his conclusions, I may say that for a person 5 feet 7 inches high, the vital capacity is said to be about 225 cubic inches—this being the ordinary amount of air which a man of that height can take comfortably into his lungs, taking the temperature of the outer air at 60° Fahr. With another inch in height—that is, 5 feet 8 inches—you would have to add 8 cubic inches to indicate the vital capacity of the lungs. If the person were an inch lower, you would have to subtract 8 cubic inches from his standard of vital capacity. Last of all, remember that the work which is done by the muscles in breathing—by the diaphragm, the muscles of the ribs, and other muscles—represents in twenty-four hours a considerable amount of work. When physiologists calculate the amount of work done in living beings, they take as their standard the force that is required to lift one ton weight one foot high, and that amount of force is called a foot ton. We may be astonished when we discover that by actual calculation, the work of the respiratory muscles has been estimated to amount to twenty-one foot tons in twenty-four hours.

Our third question was, "What do we breathe?" If you could breathe absolutely pure air, you would breathe a mixture of two gases, oxygen and nitrogen. Air is not a *chemical* compound, but a mere mechanical mixture. We may roughly say that in 100 volumes of air, twenty-one volumes of oxygen exist to every seventy-nine volumes of nitrogen. Nitrogen has no action whatever in the animal economy. Its use appears to be that of diluting the oxygen. Notice that you also get in the air, carbonic acid—(about three or four parts in 10,000 of air); watery vapour, varying according to the state of the atmosphere; a little ammonia; a gas called ozone, which is just another and much more subtle form of oxygen; and also nitrous and nitric acids. The oxygen has an all-important part to play, but the nitrogen, I repeat, appears to serve merely for dilution. In the year 1774, oxygen gas was discovered by Priestley, the famous chemist, and it was also in that year that the composition of air itself was discovered by Lavoisier, a French chemist.

After being breathed, the air, first, becomes warmer. Suppose you take air at an ordinary temperature, that is to say, 60° F., then the air which goes out of our lungs is between 97° and 99° F.—that is nearly the heat of the blood. Secondly, the carbonic acid of the expired air is increased; thirdly, its oxygen is diminished. But here you should be particular to note that we do not say it is all carbonic acid, or that it contains no oxygen. Fourthly, the expired air has its watery vapour increased; and fifthly, it contains ammonia and organic matters, which, as we have seen, come out of the blood.

What amount of air then is required for ordinary healthy breathing in the course of twenty-four hours? An adult at rest will breathe 686,000 cubic inches, or from 350 to 400 cubic feet of air in twenty-four hours. But a hard-working labourer, on the other hand, will breathe 1,568,390 cubic inches in the same period of time. Thus you see the difference in the work of respiration which increased muscular exertion invariably entails. We require a certain cubic space for healthy breathing, and so far as one individual is concerned, he should have a space of 1000 feet—that is to say, a room ten feet square and ten feet high should be inhabited by one individual alone. What amount of air, however, would be required to pass through that room in the course of an hour? The answer to this query is that 3000 cubic feet of air per hour must pass through that room for healthy breathing. You require for an hour's breathing three times the amount of air the room will hold at any one time. The average healthy adult consumes of oxygen, 10,000 grains in twenty-four hours. He produces 12,000 grains of carbonic acid in that time, and of water, nearly nine ounces. Suppose 2000 persons to be congregated, as we are, in a large building, and suppose these persons to sit in that building for two hours—the ordinary duration of a meeting, What amount of water, representing the waste matter of the body, would be exhaled by the skin and lungs together in these two hours? The answer is, seventeen gallons of water; and the amount of carbonic-acid gas which would come forth from the 2000 pairs of lungs contains as much carbon as could be extracted from one hundredweight of coals. You see how very material are the products and quantities of waste substances which are given forth from the lungs; and you see how literally enormous is the quantity of waste matter which is given out by human beings congregated together.

Now, as to the last question, How may we properly breathe? There are three items to be considered in the regulation of breathing—namely, carbonic-acid gas; organic matters, which are equally dangerous; and watery vapour, which is not quite such a bugbear as the two former items. I am afraid that to many "carbonic acid" is the mere name of a gas which can assume no importance unless they are brought face to face with it in a rather sensational and startling fashion. Carbonic acid, firstly, kills animal life when breathed in sufficient quantity. Carbonic acid was responsible for the death of 123 out of 146 persons immured in the year 1756 in the "Black Hole" of Calcutta through the cruelty of a foreign despot. That room was only eighteen feet square; it was lighted and aired only by a small window three feet square. The result was that the children died off in a few hours, suffocated by the impure air; women, also, soon succumbed; and of the miserable remnant of twenty-three that issued forth in the morning, many were afterwards cut off by the putrid fever engendered by the vicissitudes of that fearful night. Again, on the 1st of December, 1848, the steamer *Londonderry* was crossing the Irish Channel. A severe storm coming on, the 150 passengers being ordered down below, the hatches were battened down—of these persons, seventy were suffocated by carbonic-acid gas. It is carbonic acid which is responsible for sleepless nights in badly-ventilated bedrooms; it is carbonic acid which is responsible for cutting off a large number of the children of the poor through inducing early lung-disease; it is carbonic acid which, along with the exhaled organic matter, produces typhus fever; it is carbonic acid which is responsible for the somnolence of people in church—so that persons very much concerned in church affairs, and very much interested in the oratorical reputation of their clergymen, should see that the ventilation of their churches is perfectly carried out.

But carbonic acid is capable of inducing actual disease, even if it does not always kill us outright. I take the following instances from the work of Dr. Andrew Combe on the "Principles of Physiology"—a book which forms a richer repository of interesting physiological facts than any other book I know. Here is first an interesting story about the poet Crabbe:—"When ten or eleven years of age, he was sent to a school at Bungay. Soon after his arrival he had a very narrow escape. He and several of his school-fellows were punished for playing at soldiers, by being put into a large dog-kennel, known by the name of the 'Black Hole.' George was the first that entered; and the place being crammed full of offenders, the atmosphere soon became pestilentially close. The poor boy in vain shrieked that he was about to be suffocated. At last, in despair, he bit the lad next him violently in the hand. 'Crabbe is dying; Crabbe is dying,' roared the sufferer; and the sentinel at length opened the door, and allowed the boys to rush out into the air. My father* said, 'A minute more, and I must have died.'" Another instance is quoted by Combe from "Walpole's Letters." "A parcel of drunken constables took it into their heads to arrest everybody they met, and thurst them into St. Martin's Round-house. Five or six-and-twenty persons were thus shut up all night with closed doors and windows. In the morning four were found suffocated for want of air, two died shortly after, and a dozen more were 'in a shocking way.'" "A similar but less tragical case," says Combe, "occurred at Tain in Ross-shire, where several persons arrested for rioting were almost suffocated by being confined in a small closet that had been used as the safe of a bank." These instances show us tho great power which this carbonic acid has upon animal life to affect it injuriously.

Let me now show you to what extent carbonic acid exists in various situations. I have here a table of statistics compiled in 1864 by Dr. Angus Smith, and bear in mind that the normal amount of carbonic-acid gas in pure air is about 3 parts in every 10,000 parts of air. In the Chancery Court on 3rd March, 1864, 7 feet from the ground, the doors being closed, there were 19·3 parts of carbonic acid, and in the same Court, on the same day, at 3 feet from the ground, there were 20·3 parts of carbonic acid; while with open doors there were only 5·0 parts of that gas —that is to say, on 3rd March, 1864, the administration of justice in one Court in London was carried out amongst such a prevalence of carbonic acid, as I make bold to say, could neither have been good for judge, jury, nor counsel engaged therein. In the Strand Theatre, one of the smallest in London, in the gallery at 10 P.M., there were 10·1 parts of carbonic acid. In the Surrey Theatre, one of the largest, there were in the boxes at 10 P.M., 11 1 parts, and at 12 P.M. there, the carbonic acid had risen to 21·8. In the pit of the Standard Theatre, at 11 P.M., there were 32·0 parts of carbonic acid. If, I repeat, three volumes of carbonic acid in 10,000 of air form the normal quantity, you can understand how deleterious an atmosphere existed in the pit of the Standard Theatre, where the amount stood at 32·0 parts of carbonic acid in 10,000 of air. In the Queen's Ward of St. Thomas' Hospital, at 3.25 P.M., there were 4·0 parts of carbonic acid, and in Edward's Ward at 3.30 P.M., there were 5·2 parts in 10,000 of air. In Lambeth Workhouse wards there was only ·1 part; in St. Luke's, Chelsea, 7·6 parts, and the same proportion in East London (Homerton). You can thus note how carbonic acid rises wherever human beings congregate together and where the means of ventilation are inefficient. Turning to this other table you may notice that carbonic acid increases in towns over the amount exhibited in country districts. In Scotland at the summit of the hills in November, 1869, it stood at 3·32 measures in 10,000 of air, and at the foot, at 3·41. In the different postal districts of London, it ranged from 4·115 in the western and west-central districts to 4·745 in the eastern and east-central districts. In Perth and suburbs carbonic acid was present in the proportion of 4·136 in 10,000 of air; in the closest parts of Glasgow, 5·39, and in the more open parts of that city, 4·61; in Manchester, 4·42; in that city during fogs, 6·79; about Manchester middens ("of which there are thousands," says Dr. Smith), 7·74. We see that the carbonic acid rises very materially where you have decomposing organic matter contaminating the air. Lastly, where the fields begin near Manchester the carbonic acid was only 3·69. The air of Manchester contains 17 to 20 times as much organic matter as the Forest of Chamouni or the Hospice of St. Bernard. The rain of Glasgow carries down a thousand times more organic matter than the rain of the adjacent west coast. The air of Dundee, Galashiels, Glasgow, and Greenock contains 6 to 9 times as much organic matter as that of Edinburgh; and London and Manchester 3 to 5 times as much organic matter as our own atmosphere. We may, therefore, I think, as citizens of Modern Athens, congratulate ourselves upon the comparative purity of the air—though I may add that this purity is not due to our own efforts to make it pure, but largely to the prevailing winds.*

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* Combe is quoting from Crabbe's Memoirs, written by the Poet's Son.

A man expires in twenty-four hours, about 19 cubic feet of carbonic-acid gas. The breath which comes from his lungs has lost 5 per cent. of oxygen; it gained five per cent. of carbonic acid, and that breath will not sustain life for any length of time, if rebreathed. He poisons nearly 16 cubic feet of air per hour, or 380 cubic feet in twenty-four hours. Of water he gives off 9 to 10 ounces from his lungs in twenty-four hours. The organic matter accumulates in the air to a dangerous extent long before the carbonic acid makes itself felt. This organic matter which appears to be a breeding medium for typhus fever, is promoted by want of ventilation and by the insanitary conditions of our houses. We can breath air mixed with $\frac{1}{50}$th its bulk of pure carbonic acid; but add organic matter and we can only tolerate $\frac{1}{200}$th of carbonic acid in the atmosphere.

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* Analysis of the air of various localities reveals startling results in even the *comparative* quantities of organic matter present. Thus in the atmosphere of a close house the amount of organic matter is stated as 60·7; in an uncovered pigstye at 109·7; in warm weather in London streets, 29·2. Contrast with these numbers the organic matter in purer situations: Hospice of St. Bernard, 2·8; Lake of Lucerne, 1·4; open air sixty miles from Yarmouth, 3·3.

The effects of tolerance in connection with bad ventilation are extremely well noticed both in the animal world and in ourselves. Claude Bernard made the following interesting experiment. He placed a sparrow under an air-tight glass of such a size that the bird would live without the admission of fresh air for three hours. At the end of the second hour, however, a fresh sparrow was put in its place, and immediately died. The air in which the first sparrow would have survived for another hour, was so vitiated that it killed the second sparrow directly it was introduced into that medium. The effects of bad ventilation are well shown in the case of two prisons in Vienna which, I think, Professor Fleeming Jenkin mentioned in his introductory lecture. Between 1834 and 1847, in the prison of the Leopoldstadt, which was badly ventilated, the mortality went up to the high rate of 86 per 1000—51·4 per 1000 of these deaths being due to consumption. The House of Correction in Vienna was, however well ventilated, and the deaths there were only 14 per 1000, of which only 7·9 were from consumption, so that there was a balance of 43·5 deaths per 1000, due practically to foul air. Then in the cattle plague in 1866, the difference between well and ill-ventilated byres was easily seen in the number of deaths occurring in them. There were fewer deaths in draughty byres, through which a constant current of air was passing, than in those model byres where the ventilation had not duly been attended to.

As to the amount of air which it is necessary to supply each person with per *hour*, I may refer you to a table, which shows that in hospitals for ordinary patients you must give each person 2000 to 2400 cubic feet; in hospitals for epidemics, 5000 cubic feet; in work-shops—ordinary trades, 2000 cubic feet; in unhealthy trades, 3500 cubic feet; in prisons, 1700 cubic feet—that is because life in a prison is regulated automatically, and therefore you may do with less frequent renewal of air; in theatres, 1400 to 1700 cubic feet; in meeting halls, 1000 to 2000 cubic feet; in schools for children, 400 to 500 cubic feet; and in schools for adults, 800 to 1000 cubic feet. Dr. De Chaumont says that those numbers, large as they seem, are too small, and that where ventilation can be carried out beyond those figures it should be done. The effects of lights in rendering the air impure must also be noted. Two hard sperm candles, or one oil lamp, consume as much oxygen and give out as much carbonic acid as one man; therefore, a man sitting in a room with two candles requires twice as much air as he does by day. One gas burner consumes as much oxygen, and gives out as much carbonic acid as four or five men; so that, not only have we to think of ourselves in ventilation, but also of ventilation relatively to the use of gas and other lights.

What form of ventilation, last of all, can be carried out in our ordinary houses? Here let me remark, that in addressing you on the question of ventilation, it is needful to bear in mind that we cannot afford to pull down our houses and reconstruct them on sanitary principles. Too frequently, advice concerning ventilation is given on the absurd basis that everybody can rebuild his domicile in accordance with the most recent architectural and sanitary improvements. What I have to say about ventilation shall be said shortly and simply as applying to the houses of rich and poor alike, and as exhibiting easy ways of attaining, with some measure of success, an important end. Firstly, then, every room should have a fire-place to begin with; and secondly, the damper of the grate should be continually up. The fire-place is the natural ventilating shaft of our houses, as these houses now stand. I shall be told in all probability that if I counsel every person to sleep with their bed-room window drawn down from the top, the mortality from consumption will immediately rise; for there are too many people in this world abnormally afraid of draughts. In many cases I would say by all means prefer the draught and the cold, to the chances of disease from bad ventilation. Every window, then, should be pulled down (even an inch or two will suffice) from the top. Here is another plan of ventilation applicable to the houses of rich and poor alike. Raise the lower sash of the window, say three inches, and insert a block of wood of that depth from side to side of the frame, so that the sash when drawn down will rest upon it. The result will be that the upper end of the lower sash is raised above the lower end of the upper sash to the extent of three inches, so that you have a current of air passing through between the two sashes in an upward direction. This current may be deflected upwards to the roof by a sloping board or by a plate of glass placed on the upper sash.

There is also M'Kinnell's system,* which is adapted for rooms such as halls where you get direct access to outer air. Here you have two tubes, one inside the other, and both opening into the air through the roof. The heated air escapes through the inner tube, and fresh air enters by the outer tube, and is made to pass along the ceiling of the room by an inside edge at the bottom of the tube. Then there are Cooper's ventilators, Sherringham's valve, and Arnott's valve. Lastly, remember that no house should be ventilated from a common stair, which is simply a large shaft sucking up impurities. Ventilate your houses directly from the outer air; and I may add that the cupola or top light of a common stair should always be open so as to admit of the escape of air, whilst at the same time protecting the stair from direct draughts or wet. I may mention that the character of the air in a room may be readily tested by taking a clean glass stoppered 10 oz. bottle, and by stuffing into it a cloth on entering the room. By rapidly withdrawing this cloth, the air of the room enters the bottle. Then, by adding a tablespoonful of clear lime water, and shaking the bottle violently, the air may be tested. If pure, the lime water will remain clear; if the air be foul, the lime water will become turbid or milky in appearance—owing to the carbonic acid of the air forming *chalk* by uniting with the lime of the lime water. We should certainly see that in constructing our houses the wise words of Lord Bacon are remembered:—"Houses are built to live in, and not to look on; therefore let use be preferred before uniformity, except where both may be had."

In closing this lecture, let me briefly remind you of Mirza's vision, and the application of the parable with which I commenced my discourse. Mirza looked upon a scene which parallels extremely well what Mr. Darwin would call "a struggle for existence," and which naturalists tell us, goes on continually in the universe of life. The varied tribes of living beings struggle for food, for room on the earth, and for other conditions of life. That such a warfare is proceeding around us, needs but common observation to prove. In this struggle, the weaker go to the wall, and the stronger survive and flourish. It has always seemed to me that this doctrine, applied first of all to explain the production of new species of animals and plants, has an equally important bearing upon human life and destiny. Everywhere in the human area there is competition for the necessaries of life—warfare and battling for the food without which we should hunger and die. But the knowledge that this struggle exists, carries with it the incentive to gird our loins for the fray. If the survivors in the battle for the conditions and means of life and living know their business, they will provide themselves with that knowledge which is better than riches, and which will thrice arm them to fight stoutly for existence. No unimportant part of such knowledge is that information which seeks to show how and why purity of air is the great condition for health of lungs and length of days—and conversely how and why impurity of air and errors in breathing, handicap us heavily in the struggle for life. It is no slight advantage to know, and to act upon the knowledge, that not merely does well-regulated breathing diminish mortality from consumption and from typhus and other fevers in healthy bodies, but that attention to the relation of lungs and air, ensures a longer life even to those who start existence with weakly bodies or enfeebled constitutions. The preservation of health and the prevention of disease are thus the two great results which flow from attention to my subject of to-night, just as they follow instruction in the other departments of physiology and chemistry in which you are to be instructed in the weeks to come. I need not, therefore, enlarge upon a subject which carries its application and moral written full in its face. The really happy home, at the formation of which reformers of this kind or that are ever aiming, must be a sanitary home—it must, above all, be a well-ventilated home. You cannot preserve equanimity of mind in an atmosphere of carbonic acid; you cannot, I would say, "rejoice in the Lord" if you are respiring organic matter or other impurities, or if you are rebreathing your own breath or that of other people. The connection between a man's religion, his lungs, and the atmosphere, is not in any sense distant. If we have exploded the idea of the "sanctity of dirt," we may likewise extinguish the idea of the holiness and happiness of foul air. Those

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* These various systems of ventilation were illustrated by explanatory drawings.

"Sensations sweet,
Felt in the blood, and felt along the heart,"

that Wordsworth admires, are never present in the subject of impure blood and of vitiated air. The prevention of disease is likewise a part of my moral theme to-night.

"Who would not give a trifle to prevent,
What he would give a thousand worlds to cure?"

says the author of "Night Thoughts," and who, may I ask, knowing the conditions of disease that hourly encompass us, will not be up and doing in those matters which pertain to the health of the body, and to the prolonging of our lives. Surrounded by a fair and beautiful universe, breathing forth no curse upon man, but everywhere loading him with blessings and riches, the intelligent mind may well lift up its voice of thanksgiving for the nature and the beauty that gladdens heart and soul. But for none of the mercies of Nature should man feel more grateful than for the great air-ocean, and for its reviving pulsations and currents, which, freely bestowed as a condition of life, literally give to him the means of living and being. It is only when we think of all we owe to the atmosphere, and of our dependence upon it, that we can realise the importance of the topic upon which I have endeavoured cursorily to speak to you to-night. But once realising that importance, you may then appreciate at its true worth Paul's remarks, when, standing on Mars Hill and addressing the Athenian multitude, he counselled thankfulness to the Source whence came to them, as come to us, "life, and breath, and all things."

APPENDIX.

"LUNGS AND AIR."

1. The Lungs are Organs which act along with the Skin and Kidneys in getting rid of waste matters from the body.

2. These waste matters arise as the products of our bodily work—they are the ashes of the bodily fire.

3. The waste matters are—(1.) Water; (2.) a Gas called Carbonic Acid; (3.) Heat; (4.) Ammonia; (5.) Organic matters; (6.) Urea, &c.

4. The Lungs are always receiving *impure* (or *venous*) blood pumped into them by the heart. They are always sending back to the heart *pure* (or *arterial*) blood, fit for sending out from the heart to nourish the body.

5. The Lungs, therefore,—(1.) Receive waste matters *from* the impure blood; and (2.) Give *to* the blood, the *Oxygen* gas of the air we breathe in. This oxygen fits the blood anew for nourishing the body.

6. To keep the body in health we must therefore see that the air we breathe is pure. Every breath we give out contains *Carbonic-acid Gas*, which, if breathed long enough, and in sufficient

quantity, gives us first headaches, then causes drowsiness, and finally kills us.

7. We *ventilate* our houses to get rid of the Carbonic-acid Gas and other matters that come from our lungs. Every adult individual requires at least 1000 cubic feet of space to live in—a room 10 feet square and 10 feet high, represents the amount of space fitted for one person. Into this room there should pass 3000 cubic feet of air every hour.

8. Pure air is a mixture of two gases, Oxygen and Nitrogen.

There are of	Oxygen,..........	20·99	parts,	in 100 parts of pure air.
	Nitrogen,.........	78·97	„	
	Carbonic Acid,...	·04	„	
	Watery Vapour,	traces		
	Ammonia,........			
	Ozone,...........			

9. In our rooms, and *especially in bed-rooms*, the fire-place should always be left unclosed, and the *flue or damper open for ventilation.* The windows should pull down from the top, and a piece of wire gauze should be fixed along the open space at the top; or a pane of glass should be perforated with holes capable of being closed in stormy weather. All rooms, and especially sleeping apartments, should be well aired during the day.

10. A good and simple test for impure air is to take a clear glass bottle with a glass stopper, holding about 10 ounces, and wipe it carefully inside and out. On entering a room, the air of which you wish to test, we should stuff a linen cloth into the bottle and rapidly withdraw it, so as to allow the air of the room to enter the bottle. Then carefully place a tablespoonful of clear lime water in the bottle, and replace the stopper. Shake it for a few minutes; then, if the air is pure, the lime water will remain clear. If bad, and loaded with carbonic acid, the lime water will become turbid, or even milky. This is because *lime* and *carbonic acid* together form *chalk*, which gives the milky appearance.

11. A fire in an open fire-place is a good ventilator in a way. We may ventilate a room easily by raising the lower window sash, and by placing inside the frame a piece of wood three or four inches high, and an inch in thickness, and reaching from one side of the frame to the other. When the inside sash is brought down to rest on this piece of wood, it is thus raised three or four inches. A current of fresh air moves inwards and upwards to the ceiling between the sashes, and if a piece of wood or glass, sloping upwards, be attached to the top of the lower sash, the current of air will be sent upwards to the ceiling, whence it will diffuse itself through the room. Draughts will thus be avoided.

12. Lastly, remember that lung disease is prevented by good ventilation, and that we should use cold water to the chest (except when in delicate health), every morning, and take free exercise when possible, avoiding chills, however, when warm.

THE BLOOD

AND ITS CIRCULATION.

BY DR FOULIS.

On the evening of Saturday, 11th December, Dr Foulis delivered the fourth of the Course of Health Lectures in the United Presbyterian Synod Hall, his subject being, "the Blood and its Circulation, with Simple Practical Lessons." Dr Foulis said :—

LADIES AND GENTLEMEN,—THE BLOOD, as it flows in the living body, seems to be a thickish, heavy fluid, of a bright scarlet colour when it comes from an artery; but of a deep purple, or nearly black colour, when flowing from a vein.

Although to the naked eye the blood presents the appearance thus described, if we examine it under the microscope we shall find that it really consists of a colourless fluid, in which there are millions of minute coloured globules. These little globules are the real source of colour, which seems to the naked eye to belong to every part of the blood alike.

The colourless fluid portion of the blood is called the *liquor sanguinis*, or *plasma;* the coloured minute bodies are termed the *blood globules*, or *blood corpuscles.*

The blood of a man is heavier than water. Its S. G.* = 1055; that is to say, if a certain quantity of water weighs 1000 grains, the same quantity of blood will weigh 1055 grains.

Human blood has a peculiar smell, which is best perceived when blood is just drawn. It is not difficult to tell the kind of animal from which the blood is drawn by comparing the smell of the blood with the smell of the animal. The strong odour of the pig or cat, and the peculiar milky smell of the cow, are very easily detected.

In all mammals, *i.e.*, animals which suckle their young, in birds, reptiles, and fishes, the blood is of a red colour; but in those creatures which are termed invertebrates, that is, creatures which have no back-bone, the blood is nearly colourless. There are, however, a few creatures belonging to the class of worms which possess coloured red blood—sometimes it is yellowish, bluish, or greenish in colour.

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* S. G. means Specific Gravity, *i.e.*, comparative weight.

The Red Globules of the Blood in Man are so numerous that, in the thinnest layer under the microscope, they appear crowded together in such profusion as to cover each other or touch in every direction. They are so minute that 5000 of them might be placed on the head of an ordinary pin; and in such a drop of blood as would adhere to the point of a needle, there are about 3,000,000 of them; and if you took as much blood as would fill an ordinary walnut shell there would be packed away about eighty times as many of these little bodies as there are men, women, and children in the whole world. It is these little bodies that give the blood its red appearance.

Let us now describe these red blood globules more particularly. We cannot see them with the naked eye. We must use a microscope to see them. Under the microscope they appear as circular or round bi-concave discs, with rounded edges. They are about $\frac{1}{3500}$th inch in diameter, and from $\frac{1}{10000}$ to $\frac{1}{12000}$th part of an inch in thickness; so that while about 3500 of these corpuscles lying flat on their sides in one continuous line would measure one inch, it would require about 12,000 of them if they were set up on their edges.

When viewed singly, they appear of a pale, yellowish, tinge, the deep red colour which they give to the blood being seen in them only when they are seen in a heap. They are composed of a tough, elastic, jelly-like material. The outer part of each corpuscle is denser or harder than the central part, and each little corpuscle is infiltrated or stained with a red colouring matter termed *hæmoglobin.*

If a minute drop of blood is placed upon a piece of glass, and then examined under the microscope, in a minute or so the corpuscles or globules of the blood arrange themselves in slightly curved rows or chains, in which they adhere to each other by their flat surfaces, presenting an appearance like that of a roll of coins. They arrange themselves in rouleaux. In a large jar of blood, the globules after a time begin to stick to each other by their flat surfaces, forming the rouleaux, which in their turn begin to stick to each other, and thus little masses of rouleaux are formed, which gradually sink to the bottom of the jar, leaving the upper part of the blood clear and pale in colour. The corpuscles themselves are heavier than the fluid part of the blood—their S. G. = 1088.

In the blood vessels, the rapid movement of the blood keeps them diffused through the fluid. If water is added to some of these globules which are flat, they swell up, becoming quite globular or round like a ball. If the corpuscles are exposed to carbonic acid gas, they swell out, but if exposed to oxygen gas they become flattened.

COLOURING MATTER OF THE BLOOD.—The colouring matter of the blood is termed *hæmoglobin.* Its most remarkable character is its attraction for oxygen. In 100 lbs. weight of blood corpuscles there is nearly $\frac{1}{2}$ lb. of iron present.

In all vertebrate animals the blood contains red globules of which the colouring matter is the same as that in the blood of man.

In the dog, cat, rat, pig, horse, sheep, lion, monkey,—in pigeons, crows, frogs, fishes,—in the blood of all these and many other animals the blood globules are of a red colour, and the colouring matter is *hæmoglobin,* exactly the same as that in the red blood corpuscles of the human blood.

This hæmoglobin has been found to exist in the blood globules of every species of vertebrate animal. It has even been discovered in the blood of the horse-leech, and in that of the fresh-water shrimp.

DIFFERENCE IN FORM OF THE BLOOD GLOBULES IN DIFFERENT ANIMALS.—Now, although in these cases the red globules contain the same colouring matter, they themselves are of different size and form in different animals.

Thus, in mammalians, or animals which give suck to their young ones, the red blood globules are of the same circular form and disc-like figure, except in those animals which belong to the family of the camel, dromedary, and lama. In the camel and animals of that class, the red blood globules are oval-shaped, or elliptical.

The size of the red globules in mammals varies very much. Although they are all circular in their outline, they vary much in size.

The smallest red globules are those in the blood of the Java musk-deer, an animal not larger than a rabbit. The red globules in this animal are about the $\frac{1}{12325}$ part of an inch in diameter, *i.e.*, about a quarter the size of the red globules of a man's blood.

The largest red blood globule in a mammal's blood is that of the elephant—which is slightly larger than that of man.

A large animal does not necessarily possess large red blood globules ; the red blood globules of a cat's blood are larger than those of the sheep, and those of a rabbit larger than either.

The largest red corpuscles known are those found in the blood of frogs and salamanders, in some of which animals they are ten times as large as those in man.

The blood globules of almost every animal have been carefully examined and measured, and we have tables of the sizes, so that the size of the red blood globules in most animals may be compared if necessary.

In birds, reptiles, and fishes, the red blood globules are distinguished by two very marked characters of shape and structure.

In these animals the red blood globules are oval in form, and have in their centres a little granular body, called a *nucleus*. The only known exception is in two species of fishes, belonging to the family of the lamprey, in which the globules have a circular form ; but here also they are provided with a nucleus, and by this last character are readily distinguished from the circular, red non-nucleated globules of mammals.

An acquaintance with the form of the red blood corpuscles may prove of great importance in criminal cases. For instance, suppose a murder has been committed, stains resembling blood are observed on a knife belonging to the suspected murderer. He accounts for the stains by saying he has lately killed a hen or a duck. The truth of his statement may be readily tested. The suspected blood stain is moistened with a little white of egg, or other liquid of the same density as the blood. To this liquid, the blood corpuscles, if present, will probably adhere, and the microscope would readily determine whether or not they belonged to the blood of such an animal as a hen. For remember the blood globules in a man are round, in the hen they are oval and nucleated.

A woman once came to an hospital, and stated that she had lately burst a blood-vessel, and was bleeding to death. With a view of shewing that she was telling the truth, she exhibited her handkerchief saturated with blood. The doctor, before he allowed her to go into the hospital, examined the blood under the microscope, and found the globules were oval and nucleated; that they were, in fact, the blood globules of a hen. When told that she was found out, she confessed that she had killed a hen and had soaked her handkerchief in the blood.

Now, for what purpose have we blood globules in the blood? There can be no doubt that the red blood globules serve mainly as carriers of oxygen to all parts of the body. As a general rule, those animals which have few but large blood globules—such as frogs and salamanders, are lazy luggish animals; but in those animals where the red blood globules are small but very numerous, the respiration, the circulation of the blood, and all the functions of the body are increased in activity.

These little red blood globules have each a duty to perform. After their work is done they perish. We cannot move a finger or a limb; we cannot speak, or think, or laugh, without thousands of these little red globules perishing. It is calculated that every second as many as 20,000,000 of these little red blood globules perish in our bodies.

WHITE BLOOD GLOBULES.—Now mixed up with the red blood globules, we find another little body in the blood called the *white blood globule.* It is called the white blood globule because it has no colour. In this respect it is altogether different from the red blood globules. In health, there may be 1 white blood globule to every 400 or 500 red blood globules in the human blood, but in some diseases, the proportion may mount up as high as 1 to 10. In their general appearance, these white globules are round like a ball, being the $\frac{1}{2500}$th of an inch in diameter. They contain within them two or three solid-like, but very small bodies, called nuclei. It is supposed that these white globules are the parents of the red blood globules, and their little nuclei really become red blood globules.

COAGULATION OF THE BLOOD.—I will now speak to you about the clotting or coagulation of the blood. I have in this jar some ox's blood. You will see that it is made up of two parts, a solid jelly-like mass, and a watery-looking fluid. Let me explain this: If you allow blood to flow from the veins of an animal, or from one of your own veins, into a basin, and leave it to stand a short time in a room, you will find that it will separate into two parts,—one part, a sticky jelly-like mass, settles down to the bottom: and the other part, a straw-coloured fluid, called the *serum*, occupies the rest of the vessel.

The jelly-like mass is termed the "clot." The clot you see is a bright scarlet colour. What gives it this colour? It is due to the countless number of little red blood globules which are now heaped or collected together in a mass. Now the clot is not formed of these little red globules alone. In the clot there is a substance called *fibrin*. The clot really consists of an extraordinary network of fibrin, in the meshes of which are contained immense numbers of the little red blood globules.

Now I want to explain to you that this fibrin does not exist as *fibrin* in the freshly-drawn liquid blood. It begins to be formed in one or two minutes after the blood escapes from a vein or blood-vessel of a living animal. I told you that the blood itself consists of the red and white blood globules which float in a clear liquid called the liquor sanguinis or plasma. If blood is allowed to run out of a vein into a tall vessel such as this jar, the red and white globules begin to fall down towards the bottom of the jar, and would do so in course of time, just as a lot of red currants, if thrown into a jar of clean water would fall to the bottom. But, in healthy blood, in a minute or two after it is poured into a jar, the clot begins to be formed, and it forms throughout the entire mass of the blood in the form of a net-work of fibrin, consisting of an immense number of little meshes; and, as this clot is being formed the countless numbers of little groups of red blood globules are caught in the newly-formed meshes, and thus the red blood globules are prevented from falling to the bottom of the jar, and the clot itself appears as a bright scarlet mass of jelly-like substance, floating in the fluid part of the blood. It is this formation of fibrin in freshly drawn blood that brings about that change which is called the coagulation of the blood. The clot then consists of fibrin and blood corpuscles.

After the clot is formed, it becomes gradually smaller, because the fibrin in it has a tendency to contract; and as it contracts it squeezes out a clear yellowish liquid which you see occupies the jar, while the clot floats in it. This liquid which remains is now called the *serum.*

As I said before, the corpuscles of the blood are slightly heavier than the liquor sanguinis, and they sink, though slowly, to the bottom. Hence the upper part of the clot contains fewer corpuscles, and is lighter in colour than the lower part, there being fewer corpuscles left in the upper layer of the plasma for the fibrin to catch when it sets. There are some conditions of the blood in which the corpuscles run together more rapidly, and form little groups more dense than usual. These denser or heavier groups of blood corpuscles, of course, fall more rapidly to the bottom, just as a bundle of feathers falls more rapidly to the ground than a handful scattered in the air. When this is the case, the upper part of the liquor sanguinis is quite free from blood corpuscles before the fibrin forms in it. Consequently the uppermost layer of the clot is nearly white. This white part of the clot has been termed the *buffy coat.* You will easily see from what I have said that the part of the clot called the buffy coat is fibrin naturally separated from the red corpuscles.

In this vessel I have some clean white fibrin which corresponds to that fibrin which is called the buffy coat. This clean white fibrin is the clot, without any red corpuscles in it, and it is got in the following way:—

Bullock's blood, or the blood of any animal, is allowed to flow into a jar. With a bundle of twigs the blood is constantly stirred or whipped as you whip up an egg. The result of this is that the fibrin is collected on the twigs, and a red fluid is left behind which consists of red blood corpuscles floating in the serum of the blood.

Now, if this fibrin which is caught on the twigs during the whipping of the blood is washed in fresh water frequently, any red blood corpuscles that may be sticking to it become washed away, and the fibrin appears as a white stringy substance, such as I now show you.

Now this coagulation or clotting of the blood always takes place when blood escapes out of a vein or blood-vessel. The blood never clots within perfectly healthy living blood-vessels, such as veins and arteries. You will ask me what makes the blood clot, and where does the fibrin come from if it does not exist as such either in the blood globules or in the liquid part of the blood?

Let me try to answer the first question, What makes the blood clot?

I think I can best answer this question by telling you that blood in the healthy veins and arteries of a man or any animal does not clot; but directly it escapes from a vein or an artery and comes in contact with any dead material, such as the ground, or a stone, or a glass jar, or any kind of vessel, it at once begins to clot or coagulate. Or, in other words, the mere contact of dead material with blood causes the formation of fibrin in that blood. The blood then coagulates whenever it comes in contact or touches lifeless or dead material.

As the blood flows along in the living blood-vessels it remains fluid, just as we see it, immediately it escapes from a blood-vessel. If, however, a needle or a piece of wood is thrust into a living blood-vessel, the blood which comes in contact with that needle or piece of wood clots or coagulates But I have something more to tell you as to what causes the coagulation of the blood.

It is a very wonderful thing, and you all have noticed it, that if you cut your finger or prick yourself, although at first a little blood escapes from the wound, yet after a little time the bleeding ceases. Why is this? why does the wound not go on bleeding till you have lost every drop of blood in your body? Well, the blood ceases to flow from the wound, because very soon after the blood comes in contact with the cut or wounded flesh it begins to coagulate or clot, and the clot forms a plug or cork to the open ends of the little injured blood-vessels. It is the formation of fibrin or clot in the wound, and in the mouths of cut blood-vessels, that prevents us bleeding to death whenever we cut our flesh.

Sometimes, however, the blood-vessels which are cut are so large that the clot has not time to form a sufficiently firm plug to the bleeding vessels, before it is driven out by the stream of blood —for, remember, the blood does not coagulate at once directly it escapes from a blood-vessel, but it takes a minute or two to do so. When the clot is thus driven out of the wound there is danger of bleeding to death, unless proper means be taken to stop the escape of blood.

We learn, then, that the blood does not coagulate in the healthy living veins and arteries, but it begins to clot directly it comes in contact with ordinary dead matter, such as jars, cups, stones, &c., and it begins to clot directly it comes in contact with cut or wounded flesh. The fibrin, which, as I have explained to you, is the chief part of the clot, has been called Nature's Glue. Now, let me try to answer the second question, If fibrin does not exist in the healthy liquid blood as fibrin, where does it come from?

No one as yet has been able to say for certain how the fibrin is manufactured in the act of coagulation of the blood; but it is supposed that in the healthy blood, or rather in the liquid part of it, there exists a substance called *fibrinogen*, and there is another substance called *globulin*, which is supposed to be in the red blood globules. Before coagulation takes place these substances exist separately, but when coagulation takes place, the fibrinogen seizes the globulin, and by their union or combination fibrin becomes formed. And, as I have already explained to you, it is the contact of blood with cut flesh or with ordinary dead matter, which causes these two substances called fibrinogen and globulin to combine to form fibrin.

This is all the explanation I can give you as to the formation of fibrin, or nature's glue.

There is nothing more interesting than the fact, that as long as blood is in the healthy living blood-vessel, it shows no tendency to coagulate. It is supposed that the inner surface of all the blood-vessels exerts some kind of influence on the blood, and prevents it coagulating; for whenever the inner surface of a vein becomes inflamed or injured, the blood shows a tendency to clot in connection with that part. It is only the other day I heard of a lady who suffered from inflammation of the veins of one of her legs—a clot of blood formed at the part inflamed; and this becoming detached was carried by the circulation of the blood into the heart, and caused her death.

So much, then, for the coagulation of the blood.

You will observe that, besides the clot in this vessel, there is a straw-coloured liquid. This liquid is, as I said, the *serum* of the blood, or that part of the liquor sanguinis which remains after the formation of the fibrin. In this serum are dissolved a number of substances. I will boil a little of it in this flask. You see that it turns white and thick. This is owing to the presence of albumen in it—the same substance that you know as the white of an egg. Here is some white of egg dissolved in water. If I boil it, you see it becomes like the serum when boiled. It is the nature of albumen, or white of egg, to become white and solid when heated to a temperature of 170° Fahr. Now, as the serum also contains albumen, it is natural that it should undergo the same changes here that it does in the egg. Serum contains a very large quantity of albumen; it must serve some useful purpose, or it would not be there.

Serum of human blood is composed of a mixture of various substances, dissolved in about nine times their weight of water. Now, albumen is one of the chief of these substances dissolved in the serum. There are about 70 parts of albumen in every 1000 parts of blood.

Besides the albumen, we have dissolved in the serum substances called fatty and saline matters, such as potash, soda, lime, &c. The fat is stored in the serum in the form of a soapy material. You know that when oil is mixed with soda or potash, a sort of soapy material results. The presence of a lot of soda and potash and other alkaline substances in the serum is the means by which the fat is dissolved in the blood. These fatty materials are the means by which the fat of the body is built up, and they form a large part of the milk upon which the young of all animals feed. They also, by combining with oxygen in the blood, help to keep up the heat of the body.

The most important constituents of the blood are its saline substances. Our flesh and bones contain a large quantity of minerals or salts. Suppose we were to pound up a man of ordinary size in a mortar, and then analyse the constituents of which he is composed, what should we find? Why, we should discover that at least ten parts out of a hundred consist of mineral matters. We should get lime, and iron, and sulphur, and phosphorus, and many others. Now, if these substances are present in the tissues, they must be also present in the blood, because the tissues all feed on the blood, and draw their supplies from it.

But you will ask me, How do these mineral substances get into the blood? How does a hard substance like lime, for instance, find its way into the blood, and how does it reappear in the form of bones and teeth? Though lime gets into the blood, still it does not enter it as a solid; it becomes dissolved in the blood. Our digestive systems have the power of digesting food, which contains lime in various forms; and it is by our digestive systems that we take into the blood the many mineral substances found in it. See, here is a glass which appears to contain water only, but in reality it contains an egg-shell dissolved in it; the egg-shell consists of lime. By adding a few drops of muriatic acid to the water, and then placing the egg-shell in it, the latter becomes dissolved. If some of this liquid was mixed with our porridge, it would pass during digestion into the blood, and then the lime in a dissolved state would be carried by the blood into all parts of the body. When lime is required in the form of a bone or a tooth, the blood lays it down in the exact spot where it is wanted. All our bones and teeth have been formed in this way from the blood. The blood contains lime in solution, and carries it to the parts of the body which require lime. Now, it is most important that you should know that the lime of which our bones and teeth are formed can only get into the blood from the food we eat. If that food does not contain sufficient lime, then the bones and teeth are not properly formed, and they may suffer from disease. If children do not get sufficient lime in their food their bones do not become hard and firm, but remain soft, and often become bent and distorted. I am sorry to say that during the last few months I have seen a number of young children in the streets whose legs were much bent and deformed. Some of the poor little creatures I have seen had their legs almost bent in the form of a bow. Now, why is this? It is because the food of these children has not contained sufficient lime for the blood to carry to the young growing bones, and thus the bones have remained soft and yielding, and they are unable to bear the weight of the body, and thus become bent and twisted.

This is what happens in the disease called Rickets. Who is to blame for this? Why, the parents of these children. Had these children been fed upon plenty of good milk during the first year or two of their lives, they would not be now suffering from deformities.

Nature intended all infants, and even the young of all animals, to be fed upon milk. Milk would have supplied them with lime in abundance, but the parents have fed them rather upon such foods as sago, arrowroot, tapioca, cornflour, from which the young child cannot absorb enough lime for the growing bones. Consider how the big bones of a calf or a young foal grow strong. Their bones at first are soft, like gristle: but as they grow they become hard and firm, because a great amount of lime enters into their structure. These young animals get nothing but milk to feed upon for a long time, but it is quite sufficient to supply their growing bones with all the lime that is required to make them strong.

Now, when poor little children do not get enough milk and those foods which contain lime, such as porridge, their bones remain soft, and the parents may have the distress for ever of seeing their children grow up as cripples, with crooked arms and legs, instead of being fine, strong creatures, as nature intended them to be.

See, here is a piece of bone which I have placed in weak muriatic acid. By this means the bone has been robbed of its lime. You will see that I can cut it easily with a pen-knife, and I can bend it or twist it as if it were made only of gristle. This softening of the bone takes place because it has been deprived of the lime it naturally contains. In the same way the bones remain soft and yielding in young children if they do not get a proper supply of lime in their food.

Remember then that milk, and milk alone, should be the food of infants up to the age of nine months, and after that they should still get milk mixed with their other foods for several years.

I told you that, besides lime, the blood contains many other mineral substances. All these are dissolved in the blood. If you place some salt or sugar in water, you know it becomes dissolved, and disappears from sight; but it is there, because you can taste it. In the same way, all the mineral substances find their way into the blood. They first exist in the food which we eat, and, during the process of digestion, they become dissolved in the blood, and the latter carries them to all parts of the body. I said that iron is found in considerable quantity in the red blood globules, and, indeed, is the cause of the red colour of these little bodies. We medical men are often consulted by patients who seem to have lost their strength—they are pale, and, as we express it, bloodless. The cheeks and lips, instead of being ruddy in colour, are pale and colourless. In such cases we give iron as a medicine, because we believe that the blood globules are deficient in iron in such cases, and often we are rewarded by finding that our patients soon regain their healthy condition and colour. In the same way, when we think it necessary, we give as medicines sulphur, phosphorus, magnesia, soda, and potash.

Mineral Substances, such as are found in the blood of every human being, are as necessary for health as the meat, and bread, and potatoes that you eat. If you exclude all mineral substances from diet or food, you will as certainly die as if you were deprived of all flesh-forming food.

Gases of the Blood.—Now, not only does the blood contain mineral substances in it, but it also contains gases dissolved in it.

If you take up a bottle of soda water or potash water, it appears to consist of a clear liquid; but pull out the cork, and what do you observe?—why, it fizzes. This fizzing is caused by the escape of carbonic acid gas which was dissolved in the water. After a time the fizzing ceases, because a large quantity of the gas has escaped, but there is still some gas dissolved in the fluid.

In the same way as you have gas dissolved in the soda water, so you have gases dissolved in the fluid of the blood. The gases dissolved in the blood are oxygen, carbonic acid, and nitrogen, the very same as exist in the air we breathe.

In 100 volumes of blood, say quarts, you have about 50 or 60 volumes of these gases altogether; or, in other words, in a quart of blood you have about a pint of these gases altogether, about $\frac{2}{3}$ pint of carbonic acid, $\frac{1}{3}$ pint of oxygen, and about $\frac{1}{10}$ pint of nitrogen are dissolved in one quart of blood. It appears that the oxygen gas is held in combination with, or clings to, the hæmoglobin, which I told you was the colouring matter of the red blood corpuscles. So much, then, for the minerals and gases contained in the blood.

Allow me now to say a few words about the quantity of blood contained in the body of an ordinary-sized man. It is extremely difficult to find out the exact quantity of blood in the human body. In some foreign countries they do not hang the criminals; they decapitate them, or cut off their heads. Now, it occurred to some scientific men that the best way to tell how much blood is in the body would be to weigh a criminal just before his head was cut off, and then to weigh the head and trunk after the blood had drained out of them. The difference in weight would then be the weight of the blood in the body before the head was cut off. Now, as the result of many observations of this kind, it has been found that the blood in the body is about 12.5 per cent. of the entire weight of the body; that is to say, if a body weighs 100 lbs., it contains about 12 lbs. of blood.

I have now spoken to you about the red and white blood globules of the blood, the coagulation,—and the mineral and gaseous constituents of the blood,—let me now proceed to describe to you the way in which this wonderful fluid, the blood, is carried about and distributed to all parts of the body.

If it is true that the tissues and various organs of the body are in constant need of blood, there must be some special apparatus whereby this blood is distributed to them. In the upper part of the body here, in the chest, you have a powerful forcing-pump, called the *heart*, from which pipes are distributed to all parts of the body, and there is another set of pipes which carry back the blood from all parts of the body to the heart again. The pipes which carry the blood from the heart are termed the *arteries*, and the pipes which carry it back to the heart are called *veins.*

You see here (pointing to a large diagram) the pipes which carry the blood away from the heart. They are called arteries because they were supposed, a very long time ago, to contain nothing but air. Here you see the great artery of the body passing directly from the upper part of the heart, and bending backwards till it comes in contact with the spine. It passes down along the backbone, and then divides into two trunks, which pass down the legs.

Let me now say a few words to you about the structure of these arteries.

Each artery has three coats. They are not made throughout of some one substance, as a gas pipe is, but they are made up of different materials woven together.

One of these coats, the external one, is very elastic; another, the middle one, is contractile. Now we called a substance *elastic*, when it returns to its original size with a sort of spring, after it has been stretched or drawn out. Here is the aorta, a large blood-vessel, which lies against the backbone of an ox; when I pull it out it stretches and returns to its original size at once. India-rubber is elastic; we say a substance is contractile when it squeezes or contracts on itself or its contents. Now, an elastic and a contractile coat are found in every artery. The elastic one is the external one; the contractile one is the middle coat, and it always consists of a peculiar kind of muscle. The thin or internal coat of an artery is also an elastic coat, and it lies within the muscular or middle coat. Its inner surface is lined with a layer of beautiful but very small plates called endothelial cells, which allow the blood to flow over them as smoothly as if they were polished tiles.

You will naturally ask me how do the arteries end? what becomes of them? It is only by the aid of the microscope that we can answer this question.

The main arterial tubes or pipes which carry blood from the heart, divide and continue to give off branches, or smaller pipes, until they become so small that we can hardly see them. All parts of the body except the cuticle of the skin, the hair, the teeth, and the cartilages which cover the ends of bone, are pierced through and through by small arteries which are characterised by possessing the three coats which I described to you. Now, these minute arteries terminate in still smaller pipes or tubes called *capillaries.* These capillaries or hair-like tubes are so numerous that it is impossible to prick oneself with a needle without rupturing some of them.

These minute tubes ramify or branch in every direction through the different parts of the body. They vary much in size, some of them are not more than the 5000th part of an inch in diameter; the most common size being about $\frac{1}{3000}$th of an inch. You can sometimes see the minute tubes in the white of the eye when it is bloodshot. In this state of the white of the eye, the little capillaries are gorged or crammed with the red globules of the blood. Please remember that the large arteries continue to divide until the branches or offshoots become extremely small, and the smallest ones become continuous with, or join the minutest tubes, called the capillaries. Now, how do we distinguish between a minute artery and a minute capillary? The microscope again comes to our aid. Any artery has three coats, but a capillary has only one coat, which consists of a very delicate transparent membrane, with little dots or nuclei in it.

But you will ask, Where do the capillaries end? They in their turn end in very small tubes called veins. The arteries, becoming smaller and smaller, end in the capillaries, and the capillaries becoming gradually larger end in the smallest veins, which in their turn gradually become larger and larger until they join the main large trunks or pipes which carry the blood back to the heart.

You see that the arteries carry the blood away from the heart to the capillaries. After the blood has passed through the capillaries, it passes into the veins, and returns to the heart.

The veins are tough-walled tubes or pipes, and they are remarkable, inasmuch as they possess valves, or cup-like folds of their lining membranes, so arranged that, while they allow the blood to flow towards the heart from the capillaries, they won't allow the blood to flow back from the heart to the capillaries. The blood can only go in one direction in the veins, *i.e.*, towards the heart.

So much, then, for the tubes through which the blood flows during its circulation.

I will now describe shortly the forcing pump—the heart—which forces the blood through the arteries, capillaries, veins, through the lungs, and back to itself again. Where is the heart situated? It is situated in the chest, behind the breast-bone, but more to the left than the right side. The lower portion of the heart—the thinner end of it, called the apex—inclines towards the left side, where it may be felt to beat between the fifth and sixth ribs, about two inches to the left of the breast-bone.

You may get a very good idea of the size of the heart by looking at your doubled-up fist. The heart lies in a bag called the *pericardium*, almost surrounded by the lungs, which, along with some other structures, occupy the whole cavity of the chest. Here is the heart and lungs of a sheep. When blown up you will see the lungs almost surround the heart.

The heart may be described as a hollow muscular ball, divided into four cavities, by a vertical septum or partition, and by a horizontal septum or partition. The two upper cavities are called the *auricles;* the two lower are called the *ventricles* of the heart. Each of the four cavities is capable of containing from four to six ounces of blood. The walls of the auricles are much thinner than those of the ventricles. The wall of the left ventricle is much thicker than that of the right ventricle. The left ventricle is the most powerful, because it has most work to do. The wall of the left ventricle is nearly a half inch in thickness.

There are thus four cavities altogether in the heart—two auricles and two ventricles. Remember that the auricle and ventricle on the right side are quite separate from the auricle and ventricle on the left side. The right auricle communicates with the right ventricle, and the left auricle with the left ventricle, through holes about an inch in diameter, which are in the partition between the auricles and ventricles. These are called the *auriculo-ventricular* openings.

In speaking of the arteries, I pointed to the main trunk called the aorta. This large trunk is directly connected with the top part of the left ventricle. If you could pass your finger into the cavity of the left ventricle, you would be able to pass it onwards into the opening of the great arterial pipe—the aorta. Following this artery in its course, it gives off branches in every direction, which ultimately end in the millions of capillaries which I told you pierced the tissues in all parts of the body. All the minute veins into which the capillaries pour the blood, gradually end in two large venous trunks—one coming from the head and upper limbs, the other coming from the lower limbs and the rest of the body. These two large venous pipes become connected with the right auricle by an opening which you could put your two fingers into.

Now, there is connected with the top of *the right ventricle* another tube called the *pulmonary* artery, because it goes direct to the lungs. It is also a large tube, and you could easily put your finger through the opening with which it communicates with the right ventricle. And, lastly, looking at the left auricle, we find there are two or more large veins which pass into it. On tracing these veins, we find they come from the lungs; in fact, they are the tubes which convey the blood to the left side of the heart direct from the lungs.

THE CIRCULATION OF THE BLOOD.—Now let me describe to you the circulation of the blood.

I will begin with the left ventricle. Let us suppose the left ventricle is full of blood. The blood which is now about to be pumped out of the left ventricle into the great artery, the aorta, is scarlet in colour, and in a purified state. The left ventricle gives a sudden contraction, or it squeezes upon its contents. The result is that nearly six ounces of blood are forced into the large artery connected with it. Some of you may ask, Why, if there is an opening between the left auricle and left ventricle, why does not the blood pass into the left auricle, as well as into the aorta? When the left ventricle contracts, the blood cannot get back into the left auricle, because there are two large valves so placed at the left auriculo-ventricular opening that they come together like the flood gates, which you have often seen in the canal. These valves are tough membranous flaps, and they hang downward into the cavity of the left ventricle, and are fastened by their free edges to the inner surface of the ventricle by peculiar strings called chordæ tendineæ. Now you see, when the left ventricle is full of blood, and it contracts, some of the blood gets up behind these valves and they flap together, closing the auriculo-ventricular orifice. These valves would be forced backwards into the auricle, if they were not tied, as it were, to the wall of the ventricle by the little strings. Well, as the blood cannot get back into the left auricle, it is forced on into the great artery. Now I told you that the arteries were all elastic. When the blood is forced into the artery, the artery becomes distended, and being elastic it rebounds, and recoiling squeezes on its contents with the same amount of force with which it was distended.

By its recoil it has a tendency to drive some of the blood back into the left ventricle. Now this would certainly happen if there were not, at the orifice of the artery, three little cupped-shaped valves, so arranged that, while they do not hinder the passage of blood from the ventricle into the artery, directly the elastic artery rebounds and presses the blood backward into the ventricle, these little cup-shaped valves come together at their free margins, and at once stop the backward flow of blood from the aorta into the ventricle. The blood then not being able to get back is forced on through the arteries into the capillaries. It passes through the capillaries into the veins,—the veins from the upper half and from the lower half of the body end in two large venous trunks, —and by these the blood, which is now black or purple in colour, passes into the right auricle. The right auricle contracts, and the blood is driven through the right auriculo-ventricular opening into the right ventricle. The right ventricle in its turn contracts, and the blood is driven into the pulmonary artery on to the lungs.

The blood cannot get back from the right ventricle into the right auricle, because there are three valves at that opening exactly like the valves which I described at the left auriculo-ventricular opening. When the right ventricle contracts, the dark blood gets up behind these valves which flap together, and prevents the backward flow into the right auricle. It is therefore forced into the pulmonary artery. The pulmonary artery is very elastic and rebounds upon the blood within it. The blood would be forced back into the right ventricle by the rebounding artery if it were not for three little cup-shaped valves situated just within the orifice of the pulmonary artery, and so arranged that they do not hinder the passage of blood onwards towards the lungs, but they will not permit the blood to flow back into the right ventricle. The impure black blood is thus forced on into the lungs, where it passes into the capillaries, which are so numerous that if they were united they would extend for miles and miles.

The capillaries lie in the walls of the air cells of the lungs. It is said that if these air cells were spread out they would cover a surface 300 yards long by one yard wide. In the lungs the blood is spread out over this surface in the act of being purified.

It gives out carbonic acid and water and animal matters, and takes in or absorbs oxygen gas, which goes to the red blood globules. The blood is by this means changed from a black or purple colour to a bright scarlet. It then passes from the capillaries of the lungs into minute veins, which gradually become larger till they end in those three or four trunks which pass into the left auricle. The left auricle becomes thus filled with bright scarlet blood, and it gives a contraction. The pure bright scarlet blood is thus forced on to the left ventricle to be once more sent into the aorta, as I have already described, and distributed throughout the body. There are thus two circulations—the systemic and pulmonary circulation.

In the systemic circulation, rich scarlet blood is sent to all parts of the body to nourish all the tissues and organs of the body. But in the pulmonary circulation, the impure or venous blood is sent to the lungs to be purified. It then gives out carbonic acid gas, water, and animal matters, and absorbs a large quantity of oxygen gas. It becomes a bright scarlet colour, and then passes into the left auricle on its way to begin the systemic circulation. Now, you may ask me, Why is it that the blood is at one time black and at another time red? This change in colour depends upon the quantity of oxygen there is in the blood. If blood contains much carbonic acid and little oxygen, it is black or purple coloured. If it contains much oxygen and little carbonic acid, it becomes bright scarlet. In the arteries the blood is always scarlet. In the veins it is always blue. It is supposed that arterial blood is red, because the oxygen in it makes the blood globules flat or bi-concave, and these readily reflect light that falls upon them, and thus appear red; but carbonic acid gas causes the red blood globules to swell out and become round, and thus they do not reflect light, but in a mass appear dark purple or blue-coloured.

SOUNDS OF THE HEART.—If you place your ear over the heart of a man and listen attentively, you will first of all feel the beat or the impulse of the heart. The top or the apex of the heart strikes the wall of the chest between the fifth and sixth ribs whenever the ventricles contract, and at the same time you will hear two very peculiar sounds, which are called the heart's sounds. These sounds follow each other quickly, and may be closely imitated by the words *lubb—dupp.* These two sounds are succeeded by a pause, and then we hear them again. You hear the first sound when the ventricles contract. It is supposed to be produced by flapping together of the valves at the right and left auriculo-ventricular orifices; and the second, or "dupp" sound, is supposed to be produced by the flapping together of the valves at the orifice of the aorta and pulmonary artery.

The auricles and ventricles work in pairs. The two auricles contract, and then the two ventricles contract. Whenever the ventricles contract, a large quantity of blue blood is sent into the pulmonary artery, and a large quantity of red blood is sent into the aortic artery.

If a finger is placed on an artery at the wrist, what is termed the pulse will be felt—that is to say, we feel under our finger the wave of blood that is produced by the injection of blood into the already full aorta. The wave of blood as it travels onwards, expanding or dilating the vessel, produces the pulse in it. The pulse at the wrist is felt immediately after the contraction of the left ventricle. You may feel a pulse at your ankle in the artery there, but it will be felt a second or so later than the pulse at the wrist, because the distance the wave of blood has to travel is greater. When an artery is cut across, the red blood which it contains escapes in jerks. The explanation of this is, that when the heart pumps blood into a cut artery, the force which should be employed in distending the elastic walls of the artery is spent in jerking the fluid out at the cut end.

The pulse cannot be felt in either veins or capillaries. When capillaries are cut across, the stream of blood that escapes is quite steady—the blood oozes out, as we express it. This is explained by the fact that the capacity of the branches of an artery is greater than the capacity of its trunk, and the capacity of the capillaries as a whole is greater than that of all the small arteries put together. Hence the pulsation in the capillaries is so diminished in intensity that it cannot be felt. You will have learnt from all that I have now said that the contractions of the heart and the elastic recoil of the arteries are the two great forces of the circulation.

The heart in a healthy adult man contracts from 70 to 75 times in a minute. The force with which the left ventricle contracts is said to be equal to about the $\frac{1}{50}$th of the weight of the whole body; that of the right ventricle being equal to only $\frac{1}{100}$th of the same. Each ventricle is able to contain from four to six ounces of blood, the whole of which is driven into their repective arteries at each contraction. It has been calculated that the heart in twenty-four hours does work equal to about 124 foot tons—that is, the work done by the heart in twenty-four hours is equal to the amount of force necessary to raise 124 tons one foot high.

There is one more very important subject I must speak to you about in connection with the arteries, and that is the influence of the nervous system on the circulation of the blood. You must all have experienced that palpitation or jumping of the heart when you have been suddenly startled or frightened. The whole of the blood vessels and the heart are connected by nerves to the brain and spinal marrow. The small arteries throughout the whole body, as I have already pointed out, possess a muscular coat, which, by contracting, is able to diminish the capacity of the arterial tube. Now, connected with the muscular coat of each artery are numerous nerves, whose duty it is to regulate the calibre of these vessels; the result being that the nervous system is able to control the circulation of the blood in various parts.

Let me give you an example. Take the act of *blushing;* it is a purely local affection. How is it caused? An emotion sometimes pleasurable, sometimes painful, takes possession of the mind. Thereupon a hot flush is felt; the skin of the face grows red. The face grows hot and red because the blood-vessels contain an increased quantity of the red and hot fluid. Its vessels contain this increased quantity of blood because the small arteries suddenly dilate; the contractile power of the arteries being lost for a time, owing to the nerves which control the contraction being affected by a mental emotion.

During its circulation through the body, the blood is being continually deprived of some of its constituents. The numberless organs and tissues of which man's body consists are undergoing perpetual change, and in carrying out its function, some part of each organ is destroyed. Thus we cannot think, feel, or move without wasting some portion of the brain, nerves, or muscles.

The wasted or used-up material cannot remain in its original situation, where it would be not only useless but injurious. Such old material is being daily removed from our bodies to the average amount of three or four pounds. Now, to take the place of that old material daily removed, there should be daily added at least an equal quantity of fresh material. It is by the aid of digestion of food that we are able to add to the blood such new material as will take the place of that used up in the functional activity of the various organs of the body.

When we eat mutton chops, beef, bread, and potatoes, you know as well as I do that these substances do not pass directly into the blood. They must be prepared—they must be acted upon by the teeth, mouth, stomach, and bowels, and the various secretions of the alimentary canal before they can pass into the blood. Let me then give you a short sketch of the process of digestion by which the food is prepared for absorption into the blood, and for the nourishment of the various tissues.

When food is taken into the mouth, it is divided and crushed by the teeth, and at the same time it is mixed with the saliva. This fluid has the property of converting starch—such as is so largely found in arrowroot, rice, or potatoes—into grape sugar. The glands which pour out saliva are situated in the mouth; they give out nearly two and a-half pints of saliva in twenty-four hours. People who bolt their food often suffer from indigestion. Food should be chewed slowly, so as to allow the saliva to mix well with it. After being chewed and well mixed and moistened by the saliva, the food passes down into the stomach. In the stomach the albumen matter, such as meat contains, is dissolved, and part of it becomes absorbed at once. The whole contents of the stomach are passed on into the intestine. The upper part of the intestine is called the *duodennum;* as the food passes through this it gets mixed with the *Bile* and the fluid of the *pancreas.* By this means the fatty parts of the food are rendered soluble, and as they pass along the intestine they become absorbed into the blood. The mucous membrane of the intestines is arranged in the form of folds, which delay the passage of the food, and at the same time allow little vessels called *lacteals* to suck up the fluid part of the digested food called the *chyle*, which is then passed on into the blood, and conveyed in the circulation to the different parts of the body.

By means of food properly digested we maintain the healthy condition of the blood. The oxygenised bright scarlet blood travels very rapidly through the large arteries; but when it reaches the capillaries, the current becomes very slow—the blood is spread out, as it were, the object being that all the tissues may come into intimate relation with the blood. The capillaries possess exceedingly thin walls, and during its circulation through them, some of the fluid parts of the blood, by a process of exudation, pass to the tissues in which the capillaries lie, and irrigate or bathe them. But just as new material passes out of the blood, so used-up material passes into the blood in the capillaries, and now the blood begins to get black or purple coloured. Loaded with waste products it returns to the veins, and then into the right side of the heart, to be pumped to the lungs for purification, during the process of which the waste products are given off or discharged by the breath in the form of carbonic acid, water, and animal matters.

But, besides the lungs, there are other means of getting rid of the impurities of the blood. Thus the skin and kidneys eliminate a great amount of waste products. Thus the lungs give off much carbonic acid, much water, and a little urea or ammonia. The skin throws off much water and animal matters; while the kidneys throw off much water and much urea, which is a nitrogenous substance.

Oxygen is well described as the great sweeper of the body. In its passage through the capillaries it seizes upon all the used-up particles, combining with them, converting them into carbonic acid, water, urea, etc.

Now, it is by this process of oxidation, or burning off of the tissues, that the heat of the blood is kept up; and by the help of the lungs and skin the temperature is kept steady and uniform.

Every minute the heart beats seventy-five times. This goes on day after day and year after year. The blood rushes and whirls along, feeding the different organs and tissues of the body, taking up all the impurities, and carrying them to the lungs, skin, and kidneys, to be thrown off as useless and poisonous materials.

I have spoken to you several times about oxidation. Let me show you an experiment to explain what is meant by oxidation. Whenever oxygen combines rapidly with a substance, such as charcoal or carbon, it gives out much heat and light, and carbonic acid is the result of the chemical combination. (Dr Foulis burnt a piece of charcoal in pure oxygen gas.)

If carbonic acid, which is one of the impurities of venous blood, were not thrown off by the lungs and skin, the individual would certainly die in a short time. Carbonic acid, unlike oxygen, will not support life. The air we breathe contains 79 parts of nitrogen and 21 of oxygen in 100 parts; the nitrogen is mixed with the oxygen to dilute it. We cannot for long breathe pure oxygen; it would burn us off too fast. When a number of human beings or other animals are collected together in a small room, the air of the room soon becomes poisonous unless the ventilation is good, because the carbonic acid and other impurities that are thrown off from the lungs and skins of the individuals accumulate to such an extent that the rest of the good air becomes so vitiated that it is injurious to breathe it.

To keep the blood pure one must have a certain quantity of fresh air to live in. At the least a man should not live in a room which contains less than 800 cubic feet of fresh air. Oxygen is the great supporter of life and health—carbonic acid will not support life.

Let me show you the effect of carbonic acid on a burning candle. (Dr Foulis then poured carbonic acid gas on a lighted taper in a jar; the taper went out.) By this experiment we prove that while a candle will burn in ordinary air, it will not burn in an atmosphere of carbonic acid gas; and it is equally true, that while the used up tissues in the blood will burn off in the presence of oxygen gas they will not burn off in the presence of carbonic acid gas; and if retained in the blood, by not being burnt off, the individual will surely die. Hence the importance of fresh air as a means of purifying the blood. Whatever food we take must first pass into the blood. After it has performed its work—that of feeding the tissues—it is oxidized or burnt off in the way I have described, and is discharged from the system in the form of water, carbonic acid, and ammonia.

To keep the blood in health food *must* contain nitrogen. Every nitrogenous food consists of the elements of nitrogen, hydrogen, carbon, and oxygen. If a nitrogenous food is supplied to the body there is no absolute necessity of supplying any other, because every nitrogenous food contains, besides the nitrogen, carbon and hydrogen, which in the process of oxidation give out sufficient heat to keep up the temperature of the blood.

Albumen is the type of a nitrogenous food. The substance known as white of egg is albumen. No man can live on mineral, oily, fatty or starchy foods alone. He must have a nitrogenous food to mix with these. Now, although albuminous food is essential, and under certain circumstances may by itself maintain the body, yet it is a very disadvantageous and uneconomica food: it will not do to eat it alone.

For instance, albumen contains 53 parts of carbon to 15 of nitrogen in 100 parts. It has been proved experimentally that a healthy full-grown man keeping up his weight and heat, throws off from his body daily 4000 *grains of carbon* to only 300 *grains of nitrogen.* To get back his 4000 grains of carbon he must eat 7·547 grains of albumen. But 7·547 grains of albumen contain 1·132 grain of nitrogen, or nearly four times as much as he wants. Thus you see a man must eat a prodigious quantity of purely albuminous food to get the quantity of carbon out of it he requires.

This not only throws a great amount of labour upon the organs, whose duty it is to discharge the waste product of nitrogenous food; but the blood, becoming over-loaded with albumen food and its waste products, falls into an unhealthy condition, and is a cause of most serious disease.

From this we learn the importance of eating mixed food. A diet, in which nitrogenous or albuminous substances are mixed with fats or oils or starchy substances, or both, is that which is most suitable for us.

Now, I must say something to you about the proper DRINK OF MAN AND ANIMALS.

The blood of all animals, which give suck to their young ones, is very similar in composition. All animals except man drink water only with their food; but man, unfortunately for himself and his offspring, drinks besides water another substance called *alcohol*—a substance which, taken in excess, will in course of time act so injuriously in his blood, that all parts of the body—the brain, the heart, and blood-vessels especially—become dangerously affected. What is alcohol? It is "strong spirits of wine." When you drink whisky, you drink spirits of wine, flavoured with some smoky material. The intoxicating part of whisky is alcohol. Whisky contains a large quantity of alcohol. Gin, rum, wine, beer, all owe their intoxicating power to the presence of this same substance alcohol, which really is nothing but spirits of wine.

Now, alcohol, or spirits of wine, when mixed with water and certain flavouring materials, forms all the strong drink, which is so largely consumed in this and other countries.

Now, I may tell you as a fact that alcohol cannot answer any one of the important purposes for which the use of *water* is required in the system, and if taken into the blood, it tends to prevent the solution of many of the substances which are so important as nutritive materials, and which ought to be taken up as food by the tissues of the living body.

Alcohol cannot supply anything which is essential to the nutrition of the body. It is a non-nitrogenous substance. Alcohol is essentially a stimulant. When taken into the body it forces the nervous and muscular systems to do work in a short space of time which ought to be done in a long space of time. All stimulation is followed by exhaustion, and weakness results.

It is a great mistake to suppose that whisky strengthens you. It stimulates, but gives no lasting strength to the body. All of you have seen a drunken man staggering and at last fall down. A man dead drunk is one whose blood and nervous system have been poisoned by alcohol. All strong drink passes first into the blood, and then to the different organs. It is a great mistake to suppose that whisky, gin, or beer will warm you. It actually causes the blood to become colder than before. It makes the heart drive the blood to the surface of the body, and it causes the small arteries everywhere to dilate as if the whole skin was blushing. The warm, hot blood coming to the surface of the body loses a large amount of heat by radiation, and thus the temperature of the blood everywhere is reduced, and is actually colder than before. A cup of hot coffee will warm you a thousand times better than a bucketful of whisky. Alcohol also, if taken habitually for a long time, tends to make the blood-vessels throughout the entire body rotten, so that they often burst under a small strain. It also brings about disease of the brain and of the heart. It has been found that in the case of a man who drinks much alcohol, wounds heal very badly, and sometimes even a slight wound may cause his death—the blood being in a very unhealthy state. Alcohol certainly destroys the red blood globules of the blood.

Now, for these and other reasons, the habitual abstinence from alcoholic liquors is the best rule that can be laid down for the great majority of healthy individuals.

I might also have said a few words about the poisonous effects of smoking in excess upon the blood. No doubt, when tobacco is used in great moderation it is not very injurious, but, used in excess, it acts very injuriously in the blood and nervous system.

I must now, in conclusion, say a few words about the skin as an organ for purifying the blood.

An immense number of capillary blood-vessels permeate the skin in all parts, so that you cannot prick yourself with a needle without wounding some of these. A healthy, full-grown man throws off by his skin in 24 hours in the form of sweat, about 18 ounces of water, about 300 grains of solid matter, impure material, and about 400 grains of carbonic acid.

All this amount of sweat is thrown off from the blood by means of the perspiration or sweat glands which are situated in the skin. These little glands are tubular structures, and are so numerous that there are about 2800 on a square inch of the skin. On the palm of the hand there are about 3500 of these little sweat glands. Taking the surface of an ordinary man as being equal to 2500 square inches, the number of little sweat glands will be about 7,000,000 on the surface of his body.

Each of these little sweat glands is about a quarter of an inch long. There will be, therefore, about twenty-eight miles of tubing in the skin. No one will deny that serious results must follow if this drainage system is obstructed.

These pores of the skin are constantly throwing off vapour or sweat. This evaporation from the skin serves to keep the temperature of the blood at about 100° F., and at the same time relieves the blood of a large amount of impurities. If the skin is not occasionally washed with soap and water, the sweat accumulates in the sweat glands, and these being blocked up, the blood is gradually poisoned by the waste products which ought to be thrown off by the skin. You will easily understand, from what I have said, the importance of keeping the skin clean by means of hot water and soap. It has been calculated that the air cells in the lungs, if spread out, would cover a surface 1 yard wide and 300 yards long. If we add to this 28 miles of tubing that exists in the skin, you will readily see the importance of breathing pure air, and of keeping clean skins, as the best means of preserving your blood in a healthy state.

APPENDIX.

THE BLOOD AND ITS CIRCULATION:

HOW TO KEEP THEM IN HEALTHY CONDITION.

Good Food, Temperance, Pure Air, and abundance of Exercise, are the best means of keeping the Blood and the Blood-Vessels in a healthy condition.

INFANT LIFE.—Mothers' milk is the best food for infants.

When mothers' milk cannot be had, cows' milk diluted is the best substitute.

Milk is the only natural food for the young. It naturally contains albuminous, oily, and saccharine or carbonaceous substances, with the necessary minerals in proper proportion.

The following is an excellent food for Infants, up to the age of nine months:—Mix a large breakfast-cupful of milk with the same quantity of water. Add a dessert-spoonful, or less, of fine oatmeal, a pinch of common salt, and one or two pieces of white lump sugar. Boil the mixture for five or six minutes. Then strain through a piece of muslin. It is now ready for use.

PREPARATION OF FOOD FOR INFANTS.—All mixtures of milk and water should be first boiled before they are given to infants as food. By this means the seeds of disease in impure milk and water are destroyed.

MILK A GOOD FOOD FOR ADULTS.—Pure milk should form *part* of the food of all young and growing children; and *may* form *part* of the food of all hard-working men and women. Good milk is twelve times more nutritious than beer.

All food for adults should consist of a proper mixture of—

1. Flesh-forming material—*i.e.*, nitrogenous.
2. Heat-forming material—oily, hydro-carbons.
3. Saline matters—salts of potash, soda, &c.

Pure milk contains all these materials in proper quantity, and should therefore be used as food by hard-working men and women as well as by children.

If milk is taken as food, then a smaller quantity of meat is necessary. The proper admixture of albuminous, oleaginous, saccharine, and saline constituents of food, is of the first importance.

It does not matter whether the first two of these are derived from the animal or vegetable world. All that is necessary is, that the food selected should supply the needful quantity of these substances.

FOOD SHOULD VARY WITH SEASONS.—Food should vary according to climate.

In cold weather a good supply of oleaginous diet should be taken.

In heat of summer less of the fatty food, but more of the fruits and farinaceous foods, should be taken.

The use of a highly animalised diet, *i.e.*, nitrogenous, has a tendency to raise the proportion of red blood globules, the use of a vegetable diet to lower it; whilst a proper mixture of animal and vegetable diet is the best for maintaining the healthy condition of the blood.

Fresh vegetables should always be used as often as possible. They supply a large amount of saline matters to the blood.

An increase of albuminous and farinaceous, or oily food is necessary when an unusual amount of muscular force is put forth.

Water is the natural drink of man.

Individuals and whole nations maintain the highest vigour and activity of mind and body without touching whisky, wine, or beer, as articles of food. Alcohol in the form of whisky, gin, wine, beer, &c., if used habitually, causes disease of the heart and blood-vessels throughout the whole body. It makes the blood unhealthy: the mortality of persons who are intemperate between the ages of 21 and 30 is five times greater than those who are abstemious. When food is ample in quantity and quality, alcohol is altogether unnecessary and injurious.

WASH THE SKIN.—Infants, children, men, and women, should have their bodies washed frequently to remove the poisonous matters given off by perspiration or sweat.

It is calculated that a strong full-grown man throws off from his blood in 24 hours by the sweat, 18 ounces of water, 300 grains of impure solid material, and 400 grains of carbonic acid.

ACCIDENTS, EMERGENCIES, WOUNDS, AND OPERATIONS.

By Professor ANNANDALE.

On the Evening of Saturday, 18th December, Professor Annandale delivered the fifth of the Course of Health Lectures in the United Presbyterian Synod Hall, his subject being "Accidents, Emergencies, Wounds, and Operations." Professor Annandale said:—

Ladies and Gentlemen,—

Importance of Temperance and Good Health in connection with Injuries and Operations.—You have already had, and will have, valuable hints from my fellow-lecturers which ought to aid you in preserving your health; and as accidents may occur, and operations be required at any time, I should wish to impress upon you the fact, that, if any of you should unfortunately receive an injury or have to suffer an operation, the better your health, the better will you recover from your injury or from your operation.

In my daily duties at the Infirmary and in private practice, cases of serious injury and operations come constantly under my care; and when I ascertain that my patient has been temperate in his habits and careful of his health, I feel that some of my anxiety is removed, for experience has taught me that the risks connected with the accident or operation are, under the circumstances, much less than if my patient had been intemperate or in a poor state of health.

Let me mention an instance in illustration of this remark, and of others presently to be made to you.

A few weeks ago a man was severely injured at a railway station some miles out of Edinburgh. Fortunately, he was a temperate man, and in good health; fortunately also, there was not very far away a railway porter who knew what to do and how to do it, as I hope all you will know after to-night. This porter, who himself had some years ago lost a leg in the railway service, immediately used means to stop the bleeding, had him at once carried to the Royal Infirmary, where his injuries were attended to without delay, and his right arm and right leg removed, as they were both severely crushed. In less than three weeks this man was sitting up in bed, and teaching himself to write with his left arm.

This man undoubtedly owed his life—

1. To his temperate life and good health.
2. To the prompt attention of the porter.
3. To the care and attention he received in the Royal Infirmary.

Antiseptic Treatment of Wounds.—In connection with health and sanitary precautions, I wish now to say a word or two to you in regard to what is termed Antiseptic Treatment. This treatment is founded upon the scientific fact, that floating about in the air are vegetable organisms, or germs, some of which are harmless, but others appear to be the cause of putrefaction and consequent inflammation, and suppuration or "mattering" when they come in contact, as they must do, with wounds exposed to the air. As it is impossible to prevent altogether the contact of these germs with an open wound, the object of this special treatment is to apply to the wound some form of dressing which has the power of destroying or killing them. Many substances have the power of killing vegetable organisms; but it has been found that two of the most convenient for this purpose are carbolic acid and boracic acid, and more particularly the former. The antiseptic treatment has been brought to its highest point of success by Mr Lister, and to him, therefore, is due the credit of having saved many lives and of relieving incalculable human suffering. The "Listerian" method, as it is termed, requires special appliances and special dressings, which I show you, in order that you may be impressed by and interested in the subject; but when talking to you of the treatment of wounds, I will describe a more simple form of antiseptic dressing which can be employed by any of you.

Experience would appear to point to the fact that some atmospheres are less charged with injurious germs than others, and the day may come when science will establish a method of thoroughly purifying the atmosphere, so as to render it and its germs harmless; but, in the meantime, we must consider all atmospheres as more or less injurious, and consequently treat them to a course of antiseptics when they are brought into contact with open wounds. I will only at present remark that the facts I have referred to point to the importance of covering a recently-made wound as soon as possible, and applying to it some germ-killing solution or dressing.

GENERAL TREATMENT OF ACCIDENTS.—Having already made the remark that accidents may occur at any time, I am anxious, in the first place, to give you a few general hints which will enable you to assist in immediately relieving persons who may be accidentally injured in your presence or neighbourhood. If you learn to do this simply and efficiently you will have the pleasing satisfaction of feeling that you have aided in soothing pain, and you may possibly, also, be able to feel that you have done something to save the life of a fellow-being.

When an accident happens—(1.) Try to keep collected and calm, and remember that the better you keep your wits about you the more likely are you to be of use to the sufferer. (2.) Ascertain if there is any bleeding, and at once check it by the means presently to be explained. (3.) Lay the patient on his or her back, or in the position felt to be most comfortable. In most cases the patient should be placed in the horizontal position; but if the breathing is affected, the sitting or partially sitting position is the best. (4.) Loosen any of the clothes which may be tight or causing discomfort. (5.) Don't give stimulants unless the patient remains in a very faint condition for more than half-an-hour, and after this time only give them in small quantities.

(6.) Should the patient feel cold, cover the body with blankets or other wraps, apply heated bricks or some warm application, unless bleeding is continuing seriously. (7.) If the patient does not show signs of recovering within half-an-hour of the injury, send for medical advice at once, or carry him or her to a hospital. It is important that all persons suffering from accidents should be carried to their home or to a hospital as carefully as possible. For this purpose, a stretcher, barrow, or mattress may be used, which will allow the patient to lie in the horizontal position. If a proper stretcher is not at hand, any board, old shutter, door, or gate may be employed, or a temporary stretcher may be made with two or more poles or pieces of wood, with canvas, wire-gauze, or rope stretched between them. It is often, also, well to keep the clothes or wraps from pressing upon an injured part by putting over it a cradle, as it is termed. This may be made of wire, of an old box, or of hoops, in the way I show you.

TREATMENT OF INJURIES TO THE HEAD, SPINE, CHEST, AND ABDOMEN.—Injuries to these portions of the body have special risks, owing to the important parts which are contained in them. These contained organs may suffer at the time of the injury, or they may become affected as a result of it.

For this reason, it is of consequence that when the head or other parts mentioned are injured, special care should be taken to keep the patient as quiet as possible until proper medical aid is procured. Such injuries may be slight or serious; but in all, rest, in the first instance, is advisable until the danger or non-danger of the accident has been decided by a skilled practitioner. If the patient is thirsty, small quantities of water or milk may be given, out stimulants should not be administered, unless the patient remains in a prolonged faint condition. Should there be great pain in any special part, the application of a cold wet compress may soothe, and can do no harm.

TREATMENT OF BLEEDING.—Bleeding may be the result of a wound, or it may be caused by the bursting of a vein or artery. Such bleeding may take place externally or internally, and also from the nose and other passages of the body; special diseased conditions, as certain ulcers or sores, sometimes cause bleeding.

When external bleeding takes place from any cause, it is naturally very alarming to a non-professional person; but I hope to assure you all, by telling you that, with very few and rare exceptions, all kinds of bleeding are easily stayed, and by showing you how to act under such circumstances. There are three different kinds of blood-vessels in the body—the arteries, veins, and capillaries—from any one of which, or from two or the whole, bleeding may come. By means of this diagram, I illustrate these different vessels, and also explain how the character of the blood and the method of its flowing vary according to the particular vessel or vessels injured or diseased. In bleeding from the arteries, the blood is bright red, and spurts out in jerks or jets, corresponding to the beats of the heart. In bleeding from the veins, the blood is dark-coloured, and flows out in a continuous stream, or in drops. In bleeding from the capillaries, the blood oozes or wells out. If more than one kind of blood-vessel is wounded, the bleeding may be of a mixed kind. When bleeding is taking place from the external surface of the limbs from any cause—(1.) Try *direct pressure upon the bleeding point*, and keep the limb raised above the level of the body. This pressure may be made with one or more fingers, or with a compress of cotton waste, a sponge, handkerchief, or any soft substance, in the manner I show you. (2.) Should this fail to stay the bleeding, apply a ligature of cloth, rope, strong twine, india-rubber cord, or any other cord at hand, as tightly as possible round the limb *immediately above* the bleeding point, and send at once for a medical man, or take the patient to him, or to a hospital. (3.) If the bleeding is from an external wound or sore on the trunk of the body, employ the *direct pressure* over the bleeding point; and if this does not stay the bleeding, send for a medical man, or take the patient to obtain proper medical aid. (4.) If the bleeding is coming from the interior of the nose or other cavity, apply cold water or ice over the bleeding part or near it, and keep the patient perfectly quiet on his or her back. (5.) When the bleeding is coming from a diseased surface or ulcer, and direct pressure does not stay it, the compress should be soaked in a strong solution of alum, or in "steel-drops," and again applied over the point which is bleeding. Should the wound from which the blood is coming be large and gaping, you may stuff firmly into it a compress of some soft material large enough to fill the cavity. In any case of bleeding the patient may become weak or may faint, but unless the blood is flowing actively, the sign is not necessarily a serious one, and the quiet condition of the circulation during the faint often assists nature in staying the bleeding, by allowing the blood to clot, and so block up any wound in a blood-vessel. Unless, therefore, the faint is prolonged, or the patient continuing to lose much blood, it is better not to do too much to relieve the faint condition.

Bleeding may take place internally without showing any external signs recognisable by a non-professional person. The only guide to such an occurrence is a prolonged weak or faint condition following some injury or sudden illness. When this state is met with, the patient should be kept perfectly quiet and cool, and a medical man at once sent for. In cases where blood is being coughed or vomited up in considerable quantities, ice or iced water or milk should be given, and the patient allowed to breathe fresh air freely. When the blood comes from the lungs, the inhalation of the steam of turpentine and hot water mixed (two tablespoonfuls of turpentine to a quart of hot water) should be tried if other means fail.

Treatment of Wounds.—Wounds may be caused by falls, by sharp, blunt, or pointed bodies, or by tearing or crushing, so that the character and appearance of wounds vary very much. Wounds may only involve the skin and flesh without destroying any important organ, blood-vessel, joint, or bone, or they may be made serious by injury to one or more of these structures. Dirt, pieces of gravel, stone, metal, lead, glass, or other foreign body may be driven into a wound and remain there. A wound is not immediately serious owing to its extent, but according to the important parts which it implicates. When a wound has been caused by accident—(1.) Stay any bleeding in the way already described. (2.) Keep the wounded part at rest; remove any clothing which may be pressing upon the body between the wound and the heart, and place the part in the position which best keeps the edges of the wound from gaping. (3.) If the bleeding is slight, allow a stream of cold water to flow over the surface of the wound, so as to wash away any dirt or other foreign substance. (4.) If the wound is a serious one, send for a medical man, or have the patient taken to a proper place for treatment. (5.) One of the best applications to wounds of all kinds is carbolic oil (one part of carbolic acid to twenty parts of linseed or olive oil); and therefore you may always safely apply a piece of rag soaked in this oil to the wound, and keep it constantly moist by pouring on fresh oil; turpentine, oakum, or tarry substances may be used if at hand, as they all have antiseptic properties. (6.) If portions of the skin or flesh be displaced, or if the edges of a wound be widely separated, gently replace the separated parts, and try to bring the edges of the wound in contact before applying the dressing of oil. (7.) If, in addition to the wound, bones be broken or dislocated, use means to keep the injured part at rest, as in the case of fractures and dislocations, presently to be referred to. Poisonous matter may be introduced into a wound and cause serious inflammation. Poisoned pricks and wounds of the fingers are common, and often cause the painful and troublesome disease termed whitlow. When swelling and inflammation follow such an injury, medical advice should be at once sought, as early treatment will do much to prevent unpleasant results.

TREATMENT OF BITES AND STINGS.—The bite of any animal may cause simple abrasion of the skin, or one or more wounds. Unless the animal is known to be suffering from hydrophobia, there is no special risk and no special treatment connected with these injuries. Such wounds are often slow to heal, and may require soothing applications in the shape of hot fomentations, or poultices, if any irritation follows their infliction; but it is not advisable to apply caustic, as is generally done, unless the animal has shown signs of madness, or unless there is a doubt in regard to this point. Then caustic, or a hot iron or wire, should be freely applied to the wound, and a doctor consulted.

The stings of wasps, bees, and other insects require to be treated by the careful extraction of the sting when it has been left in the skin, and by the application of oil or glycerine over the injured part.

TREATMENT OF BRUISES AND SPRAINS.—When a part of the body is bruised there is swelling and discoloration of a blue or black tint. The discoloration is sometimes not much seen at first; but in the course of a few days the surrounding skin shows various shades of yellow, blue, and red. As the swelling and discoloration depend upon some bleeding into the tissues of the body, the part must be kept at rest, and in the first instance cold applied; but when the first effects of the injury have passed off, and the part remains painful, warm fomentations are often very soothing. An excellent application to a bruised part is sugar of lead dissolved in water. One small teaspoonful of sugar of lead to a quart of water makes a good lotion for this purpose.

Sprains of muscles and of joints are often troublesome injuries to recover from. They should be treated by rest, bathing with hot water, and applying soothing fomentations in the first instance; and when the swelling is passing off, by friction and careful exercise, with the addition of the support from an elastic bandage. Experience has shown that too prolonged rest in these injuries is not advisable; and, therefore, patients should not delay the exercise too long, otherwise stiffness of the muscle or joint may result. Before deciding the question of exercise in a case of severe sprain, is will be well to consult a medical man, because I should wish you to know that in weak or unhealthy constitutions such injuries may be followed by disease of a joint or other condition, which might be made worse by movement.

TREATMENT OF FRACTURES AND DISLOCATIONS.—When a bone is broken or dislocated, careful handling of the injured person is of great importance. Should a patient suffering from such an injury be roughly or improperly interfered with, the accident may not only be made more serious, but much unnecessary pain may be caused.

You judge that a fracture has taken place by the distortion, pain, and too great mobility of the part; and in a dislocation the part is distorted and fixed in some unnatural position.

A fracture should be treated—(1) By carefully removing or cutting away, if more convenient, any of the clothes which are compressing or hurting the injured part. (2.) By very gently replacing the bones in their natural shape, or as nearly so as possible, and by putting the part in a position which gives most ease to the patient. (3.) By applying some temporary splint or appliance, which will keep the broken bones from moving about and tearing the flesh. For this purpose you may use pieces of wood, stick, tin, pasteboard, wire, straw, or firmly folded cloth in the way I show you, taking care to pad the splints with some soft material, and not to apply them too tightly to the parts. The splints may be tied to the part by loops of rope, string, pocket-handkerchiefs, pieces of cloth, or any kind of cord. (4.) The patient should then be carefully taken home or to an hospital, and medical advice obtained. Should medical advice not be procurable for some hours, examine the loops and see that they are not too tight, as rapid swelling of the part may cause them to become injuriously tight very quickly.

Cases of dislocation will be best treated by placing the patient and the injured part in the position which gives the most ease, and, by obtaining medical aid, to put the dislocated bones into their proper situation.

In fractures and dislocations, complicated with one or more wounds, the wounds must, in addition, be treated as already explained. Where a wound does exist, it is of consequence that medical aid should be sought as soon as possible, for special operations may be necessary in such injuries.

Bone-Setters and Bone-Setting.—It is not my intention or wish to abuse those who are called "bone-setters." Many of them and their followers, I believe, are conscientiously of opinion that they possess some extraordinary knowledge of bones and joints, and have some mysterious power in making a bone, joint, or sinew do their bidding; and I do not for a moment deny that there are cases which may be benefited by their manipulations.

My experience is, that some of these practitioners discover bones —small ones especially—of which the most skilled anatomist is ignorant, and that they frequently decide that such unknown bones are "out;" whether or not it is possible to "put in" bones which do not exist, I leave to your judgment to determine.

Any of you are capable of treating a simple case of fracture or dislocation on common-sense principles. You might or might not be successful; but if you were successful, it is possible that your friends would proclaim you a born bone-setter. If you were unsuccessful, you would not be blamed, as it would be said that you could not be expected to know any better. The cases in which so-called bone-setting may do good are—(1.) Simple cases of fracture, dislocation, or sprain. (2.) Cases in which joints, sinews, or muscles have become stiffened and glued together from injury or other cause. (3.) Cases in which the imagination of the patient is principally at fault, and which require some active and impressive treatment to act beneficially on the mind. The energetic manipulations of bone-setters sometimes succeed in these classes of cases; and if we, members of the profession, would be a little more energetic in our treatment of such patients, irregular bone-setting would no longer be required. Seriously also, I say to you, that while experienced surgeons may be able to tell of a few patients relieved by bone-setters, they can tell of very many who were not cured, and who were permanently injured by improper treatment.

Let me also say, in regard to this subject, that complete recovery after a bone has been broken or dislocated is often slow, even if the bone be healed and in its right place, owing to the injury done to the muscles and sinews; and therefore if some weakness, stiffness, and swelling remain for a time, you need not be alarmed, but persevere with exercise and movements of the parts, rubbing with oil and bathing with hot water, which are the best means of relieving these conditions.

TREATMENT OF BURNS AND SCALDS.—Burns and scalds are dangerous, not only from their depth, but also from their extent, and the part of the body which they involve.

Even slight burns and scalds, if they involve a large surface, and especially if they are situated on the head, chest, or abdomen, are often serious. Burns and scalds are also more dangerous in young children and in old people.

In treating a burn or scald—(1.) Remove as soon as possible any burnt or heated clothing or other substance which may be in contact with the body. (2.) If the burn or scald is a slight one, wrap the part in dry cotton-wadding. (3.) If the burn or scald is extensive, apply cotton-wadding to the whole surface, and if there is much pain send for some carron oil—or, if there is at hand, any sweet or linseed oil—and soak the cotton-wadding with it, and renew the oil from time to time so as to keep the parts cool and moist. (4.) Should a burn appear to be deep, apply the cotton-wadding and carron, or other oil, until medical aid is sought.

These dressings are the best for temporary purposes, but medical advice should always be got as soon as convenient, for special treatment and applications may be required in any case. It is always well to protect the injured part from exposure to the air, and if the patient remains weak and faint same hot soup, gruel, or small quantities of stimulants should be given. Children sometimes receive a serious scald of the mouth and throat by swallowing hot fluid, or steam from the spout of a kettle or other receptacle. In these cases medical assistance should be obtained without delay, as an immediate operation may be required to prevent the patient dying from suffocation. Until the arrival of the surgeon the patient should be made to inhale warm and moist vapour, so as to relieve the fits of choking. The best plan to cause a person to inhale a warm and moist vapour in such cases, or in cases of croup, is to make a kind of tent of blankets or rugs over the patient, and allow the hot steam from a kettle to puff into it.

LODGMENT OF FOREIGN BODIES IN THE EYE, EAR, NOSE, AND THROAT.—Particles of dust, flies, small portions of stone, metal, or other substance, may lodge under the eyelids and give rise to much irritation? These should be removed as soon as possible with the folded corner of a handkerchief or any convenient instrument, and I know that many of you become experienced in the removal of such bodies from the eyes of your mates and friends. If much dirt or dust has been forced under the eyelids, it is usually best removed by syringing the eye with a little tepid water. If, after the removal of the foreign body, irritation still continues, a few drops of sweet oil dropped between the lids usually give relief, and if it does not, a cold, wet, compress should be applied over the eye. Hot lead, lime, or other matters likely to burn or irritate the eye, sometimes strike one or both eyes, and may lodge between the eyelids. These should be at once removed, the sweet oil dropped into the eye, a wet compress applied, and medical advice taken.

When the eyeball itself is injured or wounded by foreign bodies immediate surgical advice is important in connection with the preservation of sight.

Children not unfrequently introduce into their nostrils pieces of slate pencil, small stones, pieces of wood, beads, or other bodies. This accident is in no way serious, but the presence of the body may cause, in the first instance, bleeding from the nose, and afterwards a discharge of matter. It is best to consult a medical man and request him to remove the body, as unskilful attempts to lay hold of it may force it higher up into the nose, from whence it may be more difficult to remove it.

Bodies similar to those passed into the nose, and sometimes also flies and other insects, may be introduced into the ear. Unless rough attempts are made to remove these bodies, they rarely cause bad results; but if such cases are improperly handled, the body may be forced against the drum of the ear, so as to injure it, and lead to some impairment of hearing. It is wise, therefore, not to interfere in such cases, but to trust to proper medical aid. The only safe proceeding—if medical assistance cannot be easily procured—is to carefully syringe out the ear with tepid water, and this will sometimes wash out the foreign substance. If an insect has lodged in the ear, a little oil should be dropped into its cavity. Portions of meat or other food, fish or other bones, artificial teeth, or other foreign substances, may lodge in the upper part of the throat, and cause symptoms of suffocation. Life may be saved in these cases by introducing one or more fingers into the patient's throat, and pulling out the foreign body, so as to take away the pressure from the upper part of the wind-pipe. Small coins, beans, peas, and other bodies may be swallowed, and pass into the wind-pipe itself, and cause cough and symptoms of suffocation. In such accidents medical aid should be at once summoned, for fatal choking may take place at any moment.

TREATMENT OF DROWNING, STRANGULATION, AND POISONING.—When a person has been immersed in water long enough to cause insensibility, he or she should (1) Have the mouth opened, and the tongue drawn forward; and any dirt or other substance which may be lodged in the mouth or upper part of the throat removed, (2.) If possible the patient should be at once removed to a warm room, any wet clothes taken off, and artificial respiration in the way shown to you commenced. Should a warm room not be at hand, any dry clothes or wraps which can be procured must be placed over the patient when his or her wet clothes have been taken off; and the artificial respiration begun and diligently carried on. At the same time, friction with the hands should be applied to the surface of the body. The artificial respiration should be persevered in for an hour at least if the patient does not recover before this. If sensibility and breathing return, the patient should be kept warm, and small doses of stimulants given.

When a person has been subjected to strangulation, the treatment required is :—(1.) The removal of any ligature or constricting agent from the neck. (2.) The employment of artificial respiration if the patient is insensible. (3,) Friction of the surface of the body. The inhalation of certain gases, as from old wells, vats of breweries, and mines, gives rise to symptoms closely resembling those caused by strangulation, and requiring similar treatment, with the addition of dashing cold water on the surface of the body.

When a poison has been swallowed, the particular symptoms depend on the nature of the poison swallowed.

The general treatment of all cases of poisoning may be said to be—(1.) To get rid of any of the poison which may have passed into the stomach. This is done by giving emetics, such as copious draughts of warm water or of mustard and water, and by using the stomach-pump. (2.) By swallowing bland fluids, which will dilute the poison and lessen the risk of its acting injuriously upon the stomach and other internal organs. The best fluids to swallow under these are warm water, milk, chalk, magnesia, sweet oil, and white of egg. (3.) To apply friction to the surface of the body if there is coldness or tendency to insensibility, and endeavour to keep the patient awake by exercise or other means. (4.) In all cases of poisoning, send at once for a medical man, and mention to him the nature of the poison, if known, so that he may bring with him proper antidotes or remedies.

Treatment of Fainting, Fits, and Sudden Illness.—When a person faints—(1.) Lay him or her flat on the back, with the head somewhat lower than the body. (2.) Loosen any article of dress which feels tight. (3.) Should the person have fainted in a heated room, or under some exciting cause, he or she should be at once taken into the fresh air or removed from the exciting circumstance. (4.) Should the faint condition not soon pass off, dash cold water on the face and chest, and hold smelling salts or other stimulating vapour near the nostrils. (5.) Should consciousness return and the patient remain still very weak, give a small dose of any stimulant which is at hand, and repeat it if necessary. (6.) Should the patient's faint condition remain, continue the same treatment, and seek medical assistance without delay.

If a person is attacked with a fit or sudden illness, attention to the following rules is advised—(1.) Lay the patient on his or her back, and loosen any portion of the dress which may be constricting the neck or chest. (2.) Should the patient be restless and tossing about, take precautions that he or she does not sustain injury. (3.) If the fit does not soon pass off, obtain proper medical advice, and in all cases keep the patient quiet, and in the horizontal position, unless the patient breathes easier or feels more comfortable in a different position. (4.) Should great pain be complained of in any special part, the application of a hot poultice or fomentation over the painful part will often give relief. In cases of complete insensibility, which most frequently points to serious head affection, the application of ice or other cold dressings to the head and perfect rest are most likely to be useful.

Treatment of Ruptures, Varicose Veins, and Ulcers of the Legs.—Working-men, and especially those employed in certain occupations, are liable to suffer from these affections; and therefore I wish to say a few words on the best treatment for their relief.

A rupture is a swelling which depends upon a weakness or giving way of the parts which cover in the abdomen. This swelling is caused by a protrusion of a portion of the gut or other organ through the weakened part, which pushes the skin and other structures forward. The danger of such a condition is that the gut may become caught or nipped by the margins of the opening through which it protrudes, and so cause a stoppage in the canal of the bowels, and mortification of the part which is caught. The most common situations for rupture are in the groin and front of the abdomen; and therefore when a swelling occurs, or a feeling of weakness is felt in these situations, it should never be neglected. Such a swelling is distinguished by the fact that it is moveable, and generally disappears when the person lies down, or when it is gently pushed back into the cavity of the abdomen. In this state the proper treatment is the application of a truss; but medical advice should be taken as to the necessity for, and particular form of truss. When this kind of swelling becomes painful, and more especially when, in addition, it remains fixed and cannot be pushed back, medical advice should be at once sought, and, in the meantime, the patient should rest in the horizontal position, and apply a cloth soaked in cold water over the swelling.

Early recognition and treatment of a rupture is of the greatest consequence; and therefore swellings in the regions I have mentioned should be examined as soon as noticed by a qualified medical man. Ruptures most frequently are gradual in their formation, but sometimes a sudden strain or exertion will cause a rupture to form immediately.

Varicose veins of the leg are a not uncommon cause of trouble, and are especially liable to take place in persons who stand much, or who specially use their legs in their particular occupation. They are also caused by anything likely to press upon or obstruct the large veins in the leg or those inside of the body. The condition is not serious in itself, but it may give rise to weakness and painful aching of the legs, and also interfere with the proper circulation of the blood, and so lead to an irritable state of the skin, or to sores and ulcers. Occasionally a varicose vein of the leg gives way, and serious bleeding may take place if direct pressure and elevation of the leg are not at once used to stop it.

When the veins of the leg show any tendency to become enlarged, don't delay using means for their relief, as early treatment may do much to prevent the condition becoming worse or troublesome. The treatment advisable is—(1.) Relieve any tight garter or other article of dress which is likely to be interfering with the circulation of the blood. (2.) Rest the affected limb or limbs whenever you get the chance by keeping them raised above the level of the body. (3.) Apply some soft and gentle support, such as an elastic bandage, round the leg. (4.) Gently rubbing the affected limbs in a direction upwards towards the body will also assist the circulation and be useful. (5.) Should these simple means not give relief at once, consult a medical man, as some special treatment may be advisable.

Ulcers or sores on the legs give rise to much discomfort, and often interfere with a person's work and usefulness. They may be caused by varicose veins, or by any other cause which weakens the circulation—by wounds, bruises, burns, scalds, and by an unhealthy state of the constitution. If the ulcer or sore is neglected, the condition may become most unpleasant, and the healing slow and difficult. A little care, rest, and attention when the ulcer or sore is small or commencing will often be the means of thoroughly healing it, and so preventing a very distressing trouble. Whenever, therefore, a sore affects the legs, seek medical aid without delay; and above all things, rest the limb, and have proper treatment applied to the part. These sores are most frequent below the knee, and if you suffer from such a sore, and cannot completely lay up, you may rest the part by using an ordinary wooden leg or stump, on which the knee rests. In this way the leg, instead of hanging down, projects behind, and is kept at rest, and in the horizontal position.

TREATMENT OF PATIENTS AFTER OPERATIONS AND ACCIDENTS.—When a person has undergone an operation or received an injury, his or her progress and recovery depend much upon proper nursing and attention. Should any of you feel that a person in whom you are interested cannot receive this attention at home, I have no hesitation in advising that he or she should be received into and treated in an hospital.

If it is decided that the patient be treated at home, the following rules must be attended to:—(1.) A convenient and, if possible, quiet room, in regard to which the medical attendant should be consulted, is to be prepared for the patient. (2.) One relative, friend, or nurse should be selected, and should be made responsible for the nursing and general treatment of the patient; and she alone, or some one deputed by her, should receive the medical attendant's instructions. (3.) The responsible person, or her deputy, should keep a careful note of the patient's progress; should regularly and carefully administer the medicines, food, and other treatment advised by the medical attendant. (4.) Any one undertaking the care of a sick person must be prepared to encounter and to bear with irritability, peculiarities, and even fits of temper on the part of the patient, the result of his or her sick condition; and must endeavour to go about quietly, and do anything that requires to be done gently and cheerfully. (5.) Keep the air of the room as fresh as possible. Perfect cleanliness as regards the patient and everything in the room, will aid much in keeping the air sweet and healthy. (6.) If a patient's condition requires him or her to lie in the horizontal position for some time, the back and other prominent parts upon which the body lies should be from time to time examined in case bed-sores be forming. When the skin over these parts becomes tender or broken a piece of linen rag or lint smeared with lard or some simple ointment should be applied over the part, and retained by one or more pieces of sticking-plaster.

HINTS TO PARENTS ON THE PREVENTION OF DEFORMITIES AND JOINT DISEASES IN THEIR CHILDREN.—Children with bowed and deformed legs are sights too common in our streets, and as these conditions are preventable, this should not be so; and I hope that the following hints may aid you in diminishing the number of such cases. I do not refer to cases of deformity which exist at the time of birth. The bones in many young children are for a time soft and pliable, and, therefore, in such cases the bones of the legs are not able to bear the weight of the body, head, and arms without bending or becoming distorted in one direction or another. This bending may take place without any pain. When such distortions are observed the following means should be at once taken to counteract them:—(1.) Prevent the child bearing the weight of the body on the legs. This may be done either by not allowing the child to stand or walk—no easy matter as you parents well know—or by applying some mechanical support to take off the weight of the body from the legs. (2.) Give the child nourishing food and open air exercise, and if the health is not good seek medical advice. (3.) If much distortion has already taken place some simple mechanical means may be applied for the purpose of gradually rebending the limb, but this can only be successful if the treatment is used before the bones have become hardened. After this a surgical operation is the only remedy.

Young and growing girls and boys who are put to some trade or business which keeps them on their feet, not unfrequently suffer from a giving way of the arch of the foot. While this process is going on the foot or feet ache much, and if treatment is not employed the condition of flat-foot results. The proper treatment of this condition is—(1.) Endeavour to arrange that the boy or girl does not stand or walk so much on the feet, but gets some rest daily. (2.) Have the boots or shoes made to fit properly, and with the addition of a pad of cork or india-rubber placed in the inside of the sole so as to support the inner part of the arch of the foot. (3.) If there is much aching or pain apply a cold wet compress over the foot every evening, and leave it on all night.

In connection with the proper development and usefulness of the feet, I would remark that it is the duty of parents to pay some little attention to the shoeing and booting of their children. Corns, bunions, and other troublesome conditions of the feet which may interfere much with a person's comfort and progression and occupation are too frequently the result of ill-fitting boots and shoes. A little attention to this point, and a little more money spent on these articles of civilisation, will not be lost capital, but the interest will be reaped in the future. I am even inclined to say, rather no boots or shoes than ill-fitting or improper ones.

Another kind of deformity, the result of weakness, without any actual disease, is a twisting or curving of the spine to one side. This condition sometimes occurs in men, but is more common in young girls and women. Anything which causes the patient to keep the spine twisted for a time will give rise to this distortion. Thus a habit of sitting or standing awkwardly, certain occupations, lameness in one leg, and carrying babies and heavy parcels, are common causes.

It is very important that this deformity should be early recognised and treated, otherwise the spine may become permanently twisted. When any bending of the spine or tendency to it is noticed, medical advice should be taken; and if the deformity is slight, and no disease present, proper treatment will usually relieve the deformity. The treatment useful in simple curving of the spine is—(1.) To avoid any cause which is producing or aggravating the deformity. (2.) To rest on the back, chest, or side for a certain time daily. (3.) To practise gymnastic exercises likely to strengthen the muscles of the arms, shoulders, and back, such as hanging or swinging by the hands with the feet off the ground, and light dumb-bell exercises. (4.) To attend carefully to the general health, and to seek medical advice if it is affected. Aggravated cases of spinal distortion require special supports and treatment.

Our boys and young men have their football, cricket, and other athletic exercises, and have also parks to practise them in; and it is of as much consequence that our girls and young women should have gymnastic or other exercises. I should wish to see some hall or gymnasium established where, under proper superintendence, our girls and young women would have regular and proper exercises, so as to develop their figures, strengthen their bones and muscles, improve their health, and fit them more thoroughly in the future for the important duties which, as wives and mothers, they may be called upon to fulfil.

Diseases of the joints are of very common occurrence; and in many instances these conditions are aggravated or rendered serious by the want of a little care and attention at the commencement of the affection. Although a weak or unhealthy state of the constitution may cause joint disease, most frequently some injury is the active agent in producing the condition. Even a slight injury of a large joint may, if care is not taken, be followed by disease; and therefore, when a child receives any hurt to a large joint, precautions should be employed to prevent this risk. The principal precautions to be taken are:—(1.) To keep the injured joint perfectly at rest; (2.) to apply warm and soothing fomentations to the injured part; and (3.) to consult a medical man as to the condition. When a child complains of pain in a bone or joint, and is seen to move the limb or joint with stiffness or difficulty, a medical opinion should be obtained without delay; for, if the case is one of joint disease, the want of treatment for even a day or two may cause the condition to become aggravated or serious. Should medical aid not be at hand, it would be a wise precaution to keep the injured joint at rest until it is obtained. It is well also that you should know that diseases of the joints are often tedious, and may require prolonged care and treatment.

A FEW WORDS ON OUR ROYAL INFIRMARY.—In concluding these practical hints, I ask your leave to make a very few remarks on our noble Infirmary.

This is neither the time nor the place to appeal to you for money, but I have no hesitation in asking you for your sympathy and confidence in connection with this institution. I know that hard words are occasionally used, and unpleasant impressions sometimes arise in regard to the work which is done there, and much pain is given to my colleagues and myself when such words or impressions come under our experience, more particularly as we feel that we freely give our time and energies to the performance of the various and laborious duties which as physicians and surgeons we are called upon to perform. When I remind you that from 16,000 to 18,000 patients are every year treated by us, it may assist you to understand the amount of work which is performed, and it will also, I hope, explain to you how it may sometimes, but quite exceptionally, happen that a patient is apparently treated with carelessness and neglect. I say apparently, because when these so-called cases of neglect are inquired into, it will usually be found that the circumstances depend either upon some misunderstanding, or are only such as may and do occur in any institution where so large and various a community is collected together.

However much, therefore, a few and inexperienced individuals may be prejudiced against the Infirmary, I know from large experience this fact, that not more than one or two in a thousand who have been patients, and experienced the benefits of the Infirmary, have any other feeling towards it and its medical staff than that of gratitude and appreciation. Some of you, perhaps many of you, have had friends in the Infirmary as patients, and I feel confident that their opinion and experience will confirm my statement. If any of you should hear opinions expressed unfavourable to the Infirmary, I ask you, as a duty, to inquire the reasons and foundations for such expressions. If they are founded upon true facts, bring these facts at once under the notice of the Infirmary authorities, and I am certain that they will receive proper attention. If no proper reasons or facts can be obtained, then you are also in duty bound to take the part of the Infirmary, and expose the fallacies of its detractors. The New Infirmary is open to you all, and as there are now no infectious diseases treated there, go with your wives and families, at the appointed hours, and see for yourselves the patients, their comfort, and their contentment.

Such a visit will do you and yours good in every way, and will aid in exciting and increasing your sympathy for your suffering fellow-men and women.

APPENDIX.

On Accidents, Emergencies, and Operations, with Simple Lessons in connection with their Treatment.

If persons are temperate and careful of their health, they will suffer less, and recover more surely, from the results of accidents which may occur to them, and from any operations which they may require to undergo.

Accidents.—When an accident of any kind takes place, attend to the following rules :—

1. Try not to "lose your head," and remember that a little efficient aid from you may assist in saving the injured person's life.

2. Lay the person on his or her back, or, if the breathing is affected, in a partially sitting position, taking care to support properly the back and head.

3. Loosen any of the clothes which are tight or causing discomfort.

4. If there is a wound, and bleeding from it is taking place, press your fingers, a folded handkerchief, or any soft substance made into a ball, upon the bleeding part, and keep up the pressure until medical aid is obtained. If this pressure does not stop the bleeding, and the wound is on any part of the legs or arms, tie a cord of rope, twine, or anything at hand, tightly round the limb a little above the wound. This cord should be tied as tightly as possible.

5. If the person is cold, cover him or her with warm wraps after you have stopped the bleeding.

6. *Don't give stimulants,* unless the person remain very weak and faint, for half-an-hour after the accident. If after this time the faint continues, one or two teaspoonfuls of any stimulant at

hand should be given. When thirst is complained of, a little cold water, milk, or simple effervescing water, is the best drink to give.

7. If the person does not recover in half-an-hour, or if there should be bleeding or any other bad symptom, send at once for medical aid, or carry the patient to the nearest hospital or dispensary with great care.

8. When bones are broken or dislocated, handle the injured parts with gentleness, and place them in a position which gives most ease to the injured person. If the person has to be carried home, or to a hospital, before medical aid is obtained, use some simple means, such as one or more pieces of wood, wire, pasteboard, or folded cloth, and apply them so as to steady the injured part, and prevent the broken bone tearing the flesh.

9. It is well to cover all wounds as soon as possible, for exposure to the air may do harm—rags or other cloth soaked in carbolic oil (made by mixing one part of carbolic acid to twenty parts of linseed or olive oil), sweet oil, or any tarry fluid or turpentine, are the best applications to wounds until medical aid is obtained. If none of these are at hand, rags wet with cold water should be used.

10. When a part is severely bruised, apply to it cloths soaked in cold water, and renew them every half-hour until medical advice has been taken.

TREATMENT OF BURNS AND SCALDS.—1. Remove as quickly as possible any burnt or heated clothing or other substance in contact with the skin.

2. Cover the burnt part at once with dry cotton wadding or any other dry soft substance. If there is any sweet oil, fresh lard, or butter at hand, soak or smear a piece of soft rag with it, and apply this rag next the burnt part, and then cover it over with the dry cotton wadding or other soft substance.

3. If the burn is extensive or serious, send at once for medical aid, and should the person remain faint, give a teaspoonful of any stimulant occasionally.

EMERGENCIES—1. When persons *Faint*, lay them on their back with the head slightly lower than the body. If this does not relieve the *faint*, let them have fresh air, loosen any tight clothing, dash a little cold water on the face, and place smelling salts, a little pepper, or other irritating substance, near the nostrils. If the *faint* continues, send at once for medical aid.

2. When persons take a *Fit*, lay them on their back, and prevent them injuring themselves should they be tossing about. If the *fit* does not soon pass off, send for medical aid, or carry them carefully, in the lying position, to the nearest hospital.

3. When persons have been *Poisoned*, get the stomach emptied as soon as possible by giving warm water and mustard and water, and then make the person drink freely milk, chalk and water, white of eggs, or magnesia. Send at once for medical aid, and if the patient is insensible, dash cold water upon the body, and rub with the hand the surface of the body.

4. When a person has been *Drowned*, and remains insensible, open the mouth, draw forward the tongue, remove any dirt or other substance that may be in it, apply heat at once to the body, try and work the chest (artificial respiration), and rub with the hand the whole surface of the skin.

5. When a person *Chokes* while eating, introduce one or more fingers into the mouth, and try to pull out or push down any portion of food which may be sticking in the throat.

TREATMENT OF PERSONS SUFFERING FROM ACCIDENTS OR OPERATIONS:—

1. Choose a convenient, airy, and quiet room, and have it properly prepared for the patient.

2. *One* nurse, relative, or friend, should take the entire charge, and carry out, regularly and strictly, the doctor's instructions as to diet, medicine, and other treatment. If necessary, the person in charge may depute another to act in his or her place at convenient times, but no one else should interfere.

3. Keep the patient, clothing, and furniture as clean as possible, and do not allow anything offensive to remain in the room.

4. Move about the room quietly, be gentle and cheerful in your attentions, and try to bear calmly any irritability or temper on the part of the patient.

HINTS TO WOMEN REGARDING THEIR HEALTH, HABITS, AND OCCUPATIONS.

By ANGUS MACDONALD, M.D.

This subject is a wide one, and embraces in fact the whole sphere of woman in life and society. Such a broad view of the matter is inconsistent with the limits of a single lecture. Accordingly, it behoves me, in the endeavour to be as useful as I can, to select a few salient points and direct your attention to them. In doing so, I propose to consider certain points that affect more especially—

1st. The Girl.
2d. The Young Woman.
3d. The Married Woman and Mother.

Habit is well called second nature. Our habits rapidly become part of our ordinary selves. Our actions tend to repeat themselves —we passing gradually from the position of masters to that of slaves to our habits.

It is, therefore, of the first importance that we should early form regular and proper habits, and conduct our lives and conduct according to the moral and physical laws of our being, and not in violation of these.

Observation of the laws of health is, I need scarcely remark, equally necessary for men and women.

But with the conditions of health common to both sexes, I have nothing to do at present. They form the burden of other lectures in this course.

I am charged specially with those matters which concern woman as woman, and which are indeed peculiar to her sex. As these subjects require to be handled with some delicacy, I deemed it prudent to avoid having a mixed audience. In that way I hoped to be able to speak to you with greater freedom, and to avoid entirely any embarrassment on your part or mine.

1. The Girl.—From birth upwards we see in the female the impress of feminine instincts that distinctly separate her from the male, and indicate her fitness for her particular sphere and duty. Thus, the little girl takes particular pleasure in playing with her doll, and cares for it with a motherly solicitude and anxiety; whilst her brothers as naturally take to playing at horses or some such boisterous amusement, in which their sister can only be persuaded to take an occasional and fitful interest.

The loving, receptive, and clinging nature of the girl develops to the careful observer in contrast with the wild, adventurous, but withal energetic nature of the boy. Train a girl among a family of boys, and let her see nothing but their ways, she may grow up a good bit wild and rough, but her girlish tendencies nevertheless find their way to the front, and constantly exert their influence upon her brothers, as they upon her. The object of training is not to eliminate the feminine tendencies in the girl, for these are her crown and glory,—it ought to foster, regulate, and refine them,—to prevent the over-development of any single quality, and to bring the whole tenor of her being into harmony.

We should endeavour to make our girls as perfect girls as possible, so that they may grow up good and useful women and mothers, in the same way as we endeavour to make our boys as perfect boys as possible, that they may, when they grow up, prove themselves good and useful men. But as feminine tendencies manifest themselves early, we understand that, from her tenderest years, the girl requires special care and attention, if she is to develop into a useful woman.

Much of the misery of after life, and many deaths of children and of mothers, result from neglect of practicable precautions in the management and upbringing of little female children. If a man happens to suffer from a deformity, such as a hunchback or a short leg, we commiserate him on his misfortune, and this we do with all due sincerity. But in his personal misfortune all his ills terminate. It does not, or at least needs not interfere with his enjoyment of life or with his usefulness, and certainly does not endanger his existence.

Such is not the case with the woman. Any deformity in the skeleton of the girl is extremely apt to be propagated to her bony pelvis. When that is so, it either entirely unfits her for giving birth to living children, or makes her deliveries so severe and dangerous, that she is exceedingly likely to succumb before the termination of child-bearing life to some of the many complications that arise from the pelvic defect, or the artificial means needed to effect delivery. The results to the offspring of a woman with an ill-formed pelvis are still more disastrous, ending often in unavoidable death at delivery, or in mutilation and permanent injury. It is, accordingly, of the greatest importance that the skeleton of a girl should be symmetrical and well-formed to avoid those disastrous consequences.

The law of selection that lends a preference in marriage to the well-formed and well-favoured woman, no doubt, if universally acted upon, has its aspect of benevolence to the unsymmetrical and ill-formed, and is not altogether unkind to them. But, on the other hand, affection cannot always be regulated by the cold laws of physiology and logic; and it is therefore of importance for mothers, in the training of their girls, to avoid, by all means in their power, the causes that tend to stunt or deform the skeleton of their daughters.

The most common disease that leads to deformity of the bony tissues is rickets. This is a disease of early childhood, depending, so far as we understand its cause, essentially upon some defect in the nutrition of the child, and resulting in abnormal softening and flexibility of the bones, out of which arise numerous deformities in their shape. It will, therefore, be incumbent upon you to attend with care to the rules which Dr. Underhill is to give you for the feeding of young children, so that the essential cause of this cruel disorder may be combated at the outset.

Then supposing the disease should occur, care ought to be taken by diligent application for medical advice, to make the attack as mild as possible, and to avoid gross deformity of the pelvis, by discouraging the child from attempts to move about whilst the bones are soft and flexible.

But even when the bones are not unnaturally soft through deficiency of earthy matter as in rickets, a female child, if compelled to carry weights that are too heavy for her, may thereby have her pelvis deformed by simple pressure of this weight, and that of her trunk upon the pelvis. This heavy kind of work ought therefore not to be assigned to girls.

The observation of the general principles of health ought to be strongly impressed upon parents in dealing with their girls. Boys by playing at foot-ball, cricket, &c., have abundance of opportunities to develop their muscular system, and to lay the foundations of a healthy constitution. But nothing like corresponding concern is bestowed upon our girls. Among the well-to-do classes of society, it is reckoned by prudish governesses unlady-like for girls to romp about freely in a public park; and, among the poorer classes, the unfortunate girl is kept tending baby or looking after domestic duties, varied perhaps with the questionable amusement of running an errand. In consequence, the lungs of the girl are only seldom filled with the fresh air of heaven, and her circulation is never excited by the healthy stimulus of exuberant physical activity. If more attention were paid to the physical development of our girls, we should have fewer delicate wives and daughters, and the whole race would be stronger and healthier.

I do not wish them to engage in football, or in cricket, but I do contend for more use of the skipping-rope and of their legs, and for much moreout-of-door amusement, so that the girls' muscular systems should be better developed, their blood better aired and richer. In this way, they would be enabled to enter upon the trials of life with robuster health. The more perfectly the girl's physical nature is developed, whether with walking, running, calisthenics, or otherwise, the more likely is she to turn out a useful woman, and a happy and healthy wife and mother. The attention paid to the physical training of boys is very considerable, but, so far as I can judge, not a bit too great. But little is done for girls in that direction. It is assumed that they do not need it. But this is a great mistake and ought to be remedied.

The emotional and imaginative nature of the girl is particularly sensitive and mobile. Consequently, care should be constantly exercised that these qualities of the mind should not be over-stimulated. Young girls should be kept, as far as possible, from disagreeable sights, and from any prolonged excitement, likely to wear out their nervous system, and land them in a condition of after-depression. Music itself, that charm of life, is frequently too severe a trial for a sensitive girl if much indulged in. It is apt to add to the natural too great sensitiveness, and to develop morbid feelings. But the best protection against the supervention of those irregular nervous phenomena, which, in their collective capacity, we are wont to style Hysteria, and which so greatly trouble the female sex, is the cultivation of a sound physical frame, conjoined with the necessary moral training.

The cultivation of the habit of self-restraint, of self-denial, and the necessary attention to the calls of duty on all occasions, form elements that can never be left out, without serious injury in the training of either girl or boy.

Premising now that it is of great importance in the upbringing of a young girl to attend to her moral training and physical health, and especially to the maintenance of a sound frame and healthy well-formed skeleton, we now proceed to consider some points that require special notice when the girl passes from the state of girlhood to that of the young woman.

2. THE YOUNG WOMAN will always demand special attention from her friends, whatever care is bestowed upon or withheld from the

young girl. At this time of life, the girl begins to awaken to the consciousness of her sex. Mental feelings of coyness and modesty, to which she had previously been a complete stranger, begin to develop themselves. Her physical appearance at the same time alters —she becomes plumper and rounder, and changes from the shape of the girl to that of the woman.

Menstruation.—The appearance of the monthly periods marks the completion of the transition from girl to young woman. Much attention and care is needed by young women at the first appearance of the monthly flow. I should advise all mothers to warn their daughters of the near approach of this phenomenon, so that neither the symptoms which ordinarily precede it, nor the flow itself may cause them either consternation or distress. This is a point on which many mothers, from feelings of false delicacy, are frequently remiss in their duty towards their daughters. Particular attention ought to be paid to the first few menstrual periods, as in proportion as these are safely and painlessly passed much of the future comfort and happiness of the woman throughout her menstrual life depends. Every one conversant with these matters knows how painful menstruation is apt to repeat itself throughout menstrual life, if it is neglected at first, and how intractable it may become. Accordingly, it is seen how necessary it is, by strict attention to hygienic principles, to safely tide over the earlier periods, so as to avoid such a mournful catastrophe as a life of recurrent paroxysms of pain. It is also agreed, that it is much more easy to cure painful menstruation at first than afterwards.

I should like to be allowed to state, in this place, that the monthly flow ought to pass painlessly, and with little or no discomfort. It is necessary to state this pointedly, as I constantly meet with patients, who observe, on being questioned, that they experience only the usual feelings of distress at these times, assuming that the phenomenon is necessarily painful. This is not the place to lecture upon the diseases of women, but I might be allowed to observe in passing, that, among the more common causes of painful menstruation, are (1) weak health, conjoined with a nervous temperament; and (2) congestive or inflammatory affections of the womb or parts adjoining it.

We cannot alter a woman's inborn temperament, but we can train up a girl by physical and moral means so as to educate her whole being properly, in order that she may possess a sound mind in a sound body, and by avoiding all causes of over-excitement and nervous exhaustion, we may take all possible precautions that, at this particular and all-important period of her life, she may meet the struggle with as little morbid nervous action as possible. It is not well-developed, strong, healthy girls that give way to these disturbances in the region of the nervous system. It is your puny, unhealthy, ill-nourished ones. Among the classes of society, in which life is easier, these sufferers read novels of an exciting character, are highly æsthetic, much given to music, and but little to healthful exercise and bodily exertion. Among the classes of society, where such nonsense is not allowed, the sufferers are the ill-nourished, puny, ill-housed, self-willed, over-excited, and frequently overworked.

Inflammatory and congestive causes of painful menstruation are much in the power of women. The young girl ought to be instructed that, at the periods, she requires to be specially careful of herself, and that, if she expose herself to undue cold or over-exertion, she is likely to start morbid processes that are not of a transitory nature, but may continue for her whole menstrual life. In no department of health is the proverb—"Better keep well than mend"—more applicable than in this relation. The barbarous habit of tramping blankets at the annual cleanings in country places is frequently traced as a cause of permanent injury to young women, if they happen to be called upon to perform this service in connection with a monthly period. That, or any similar duty, ought certainly to be declined under such circumstances. Throughout menstrual life, and not merely at the first onset of the flow, a woman requires to exercise prudence at the monthly times, if she expects to retain her health in its completeness, and to avoid all influences likely to originate the miserable conditions which group themselves around painful menstruation.

In cases of painful menstruation, one of the best simple measures to adopt is to bathe the feet in hot water and mustard. Much relief may frequently be afforded by the use of a hot hip bath, or by the application of a poultice to the lower part of the belly. Hot drinks are also beneficial. In severer cases, medical advice ought to be sought.

I should like to warn mothers against accustoming their daughters to the use of spirits on these occasions. No doubt spirits and hot water relieve the pain. The remedy is, however, a very dangerous one. Every medical practitioner of experience in the diseases of women can point to cases in which women have been led to become habitual drunkards, in consequence of the free use of spirits to relieve the distress accompanying painful menstruation. A further melancholy accompaniment arises from the fact that such patients, if they live long enough, are not found to give up their bad habits when the original cause ceases, but to continue them long after the conclusion of menstrual life. Besides this, the free use of stimulants, not to say necessarily the abuse of them, is well known to predispose to diseases of a chronic inflammatory nature in important organs (the ovaries) intimately connected with the womb. This forms an additional incentive to the observance of the strictest temperance by females.

When I am on this subject, might I be pardoned for enjoining upon women the necessity of special precautions in the use of alcoholic drinks generally? The opportunities of seclusion which women possess much more than men, afford manifest temptation to the indulgence in the habit of secret drinking. That is unquestionably the worst form in which the curse of drinking can attack humanity. A woman somehow is more apt than a man, once she has disgraced herself, to plunge headlong and heedlessly into further depths of degradation. Whatever is the explanation, and I have none to offer, it is far more difficult to make a woman who has become a habitual drunkard a sober woman, than it is to reclaim a man from drunkenness to sobriety. God, who with awful emphasis has fixed His curse upon the drunkard, knows how terribly hard it is for either man or woman to overcome this vice once it has gained the mastery. But, in my experience, there is much more hope of success with a man than with a woman. I have seen many women habitual drunkards, and I have known some of them mend their habits greatly. I am not sure if I ever saw one who fairly mastered the demon of drink.

It is to be expected that, though pain and distress may accompany the first menstrual periods, if due care is taken of the young woman for a few periods, the distress shall disappear in the future. I need hardly say that women ought not to employ strong purgatives during the periods, and that they should not use any powerful medicines. It is, however, absolutely necessary that they should be more than usually careful to attend to personal cleanliness at these times.

Now, a word or two about the REGULARITY OF THE RECURRENCE OF THE MONTHLY PERIODS.

A healthy woman ought to begin menstruation about the fourteenth or fifteenth year, and ought to menstruate every twenty-eighth day, unless she is in ill health, is pregnant, or is suckling a child, until about the forty-fifth or fiftieth year, when the recurrence of the flow ceases. That is, the normal appearance, disappearance, and frequency. But, of course, there are many exceptions.

But in this connection I want to insist upon what I consider is an important fact—viz., that women as a rule over-estimate the importance of arrest of menstruation, and thereby are led to neglect other symptoms of ill health that are of much greater value.

There is nothing in the monthly flow that can injure the woman if it does not come away. What is discharged is essentially blood, and nothing more. Its non-appearance will not poison the woman's blood as would happen if the secretion from her liver or her kidneys were arrested.

Accordingly, when a young woman, concerning whom there is no suspicion of pregnancy, ceases to menstruate, and you cannot trace the cause of it to a sudden arrest from exposure to cold or such like, the attention of those about her ought to be directed to her general health. Is she feeble and bloodless-looking? Then she needs good food, open-air exercise, and steel in some form or other. Has she a troublesome cough or an exhausting diarrhœa, and is she losing flesh? Then serious diseases of the lungs or bowels are to be apprehended, and appropriate measures adopted to prevent their advancing. In fact, when a young woman ceases to alter, the first thought and attention ought to be directed to her general health to see that it is attended to, and the necessity of restoring the monthly flow ought to occupy only a subordinate place in the thoughts of mothers. The absence of the flow in such cases is really of a conservative nature, the blood which would be thus discharged being retained for the wants of the economy.

Excessive Flow at the menstrual periods is a symptom of various diseased conditions which ought always to lead the woman to consult a medical man, as the prolonged and repeated drain of strength through its continuance is very dangerous indeed.

Tight Lacing is a habit so frequent among women and so exceedingly injurious that I cannot refrain from referring to it. The practice arises from mistaken ideas of female beauty. The tight lacing results in ugliness. It replaces the exquisitely beautiful outlines of the female figure by the mischievous creations of the dressmaker's fancy. Nature never meant a woman to be degraded by being squeezed into the shape of an insect.

But, in addition to violating the true principles of taste and beauty of form, it leads directly to disastrous consequences in respect to the woman's health. It compresses the liver; it is not uncommon in the pathological theatre to see the liver deeply indentated by the marks of the ribs, as a result of tight lacing. It interferes with the free play of the lungs, and thus gradually deteriorates the health by defective aeration of the blood. It displaces the abdominal organs downwards, and thus leads to falling down of the womb, to rupture, and other displacements. It opposes the return of venous blood from the lower limbs and the abdomen, and thus leads to varicose veins, to piles, and other such like evils. By obstructing the circulation it tends to interfere with the action of the heart, putting extra strain upon the central organ, and thus acts injuriously upon the circulation and nutrition generally.

The moral deducible from these facts is that there ought to be no tight lacing. If ladies must wear stays, and I for one think they would be far happier and would look much prettier without them, they surely ought to wear them loose, and to carry their skirts, not on tight bands tied around their waists, but over their shoulders.

Imperfect Clothing.—This is another cause of much bad health among women. Many women labour under the delusion that they cannot wear flannels, and they expose themselves to the inclemency of our variable and inhospitable winter climate in thin cotton dresses. Few people cannot wear flannel next their skins after a fair trial. Some ladies who cannot do so manage to wear silk next the skin and flannel over that. Every woman who has proper regard to her health ought to wear flannel all through our winter. This forms the best protection against cold. Remember colds are not to be trifled with. We never know how a cold may end and what forms of disease it may give rise to. Time was when we thought that to establish consumption we needed an inherent tendency in the individual. With a better knowledge of the true nature of this disease we know that from an ill-cared-for cold in the chest the strongest and healthiest may quickly fall a victim to consumption.

Then again, rheumatic fever is very common among the young of all classes, but particularly so among hard-working servant girls. This leads every year to untold misery. Rheumatic fever, much more than any other fever, is apt to leave disastrous traces of its action in the constitution. It acts specially upon the heart, and is the commonest cause of heart disease. The fever seldom kills directly, but it acts injuriously by weakening and perturbing the central organ of the circulation. In consequence of this the victim's health is permanently shattered, the seeds of much misery sown, and, in almost all cases, the period of life abbreviated. Surely, to avoid such a catastrophe some care ought to be given to make sure that our women are warmly clad and able to resist the severity of our climate.

All classes of society in different ways are victims of this mania for light clothing. Ladies in the higher ranks suffer by wearing low-bodied evening dresses, in which they drive home from places of entertainment in the cold winter nights in draughty cabs or carriages after being overheated, and perhaps also exhausted, in the ball-room. Domestic servants get overheated and tired out in the kitchen and laundry, and, on leaving these, are exposed to cold through neglect to dress warmly. Sometimes I fear the anxiety of wearing showy dress leads to selecting clothing for the sake of appearance and not of comfort. If a shop-girl or a servant cannot afford to have her dress both showy and comfortable, she ought always to choose the latter. I ought to mention also here that imprudent exposure to cold may readily induce disease of the kidneys, of the womb, of the bowels, and indeed of various organs.

It would lead me too far to refer to particular employments that are specially trying for women. It is gratifying to notice the efforts that have lately been made to induce shopkeepers to provide seats for their girls when they happen to be disengaged. I hope this will become general, as the continuous hanging on their feet of the girls from "morn till noon," and from "noon till dewy eve," is very exhausting, and is surely unnecessary.

The use of the foot sewing-machine is fraught with troubles to women. A foot-sewing-machine should, therefore, not be undertaken by any woman who has any tendency to womb disease.

Girls who are compelled to lead sedentary lives in earning their living ought to take every opportunity they can to obtain the needed out-of-door exercise in their spare time.

Habitual Constipation is a common failing with women. It is apt to land them in great trouble. It doubtless predisposes greatly to, as well as aggravates many diseases of the womb and parts adjoining of a congestive or inflammatory nature. It becomes a matter of the greatest importance to avoid this habit. As far as possible, this ought to be done without the use of purgatives. Regular exercise is one of the best measures to help in overcoming the tendency. The systematic use of a cold bath each morning is another useful adjunct. The use of fruit or preserves at breakfast is also valuable. Porridge, eaten with treacle instead of milk at breakfast, sometimes succeeds.

In some cases a glass of cold water, drunk either the last thing at night or the first thing in the morning, will succeed. At times a cold water compress, bound over the bowels at night, may effect the result wished for.

Whole wheat boiled until it is thoroughly softened, and then eaten as a pudding, sometimes succeeds, as pointed out lately in the *British Medical Journal* by Dr. Rabagliati, of Bradford.

Women ought to remember that much good results from regularity in attending to the requirements of nature. If all these measures fail, an occasional enema of cold water may be used, or it may be necessary to employ occasionally an aloetic laxative, such as Hamilton's or Christison's pills. It is better not to employ salines, such as Epsom salts, as they constipate after they have exerted their first action.

The sedentary habits of women are not always a necessity ; often they are the result of choice. That should not be. With active habits these drawbacks to comfort very frequently disappear.

Many things more could be added to the regulation of the young woman's health and habits ; but the time allotted will not permit me.

3. I now pass on to direct attention to some things that specially concern MARRIED WOMEN AND MOTHERS.

Suppose a young woman is married, and has become pregnant, certain general principles ought to regulate her conduct during its currency. In the first place, however, I would take leave to say that the pregnant woman ought to live very much according to her usual manner of living, but ought to guard against certain awkward contingencies.

First among these may be placed the risk of abortion or miscarriage, which occur in one out of every tenth pregnancy. Abortion is most likely to happen before the end of the fourth month. But pregnancy may be abnormally terminated at any period, and in the latter two months there is again increased risk of premature delivery.

The causes of abortion are very various, and many of them are entirely beyond the control of the woman. But certain of them she should be able to guard against. Among the latter we may mention the risks from lifting very heavy weights; from recklessness in stepping from a carriage or train on to the road or platform; leaping from heights; or anything which subjects her body to sudden jerks or succussions.

But what I would more particularly urge in this connection is the necessity for women who have aborted to take proper care of themselves until they have completely recovered from the accident. Very great misery results from ill-cured abortions. You have all heard that it is better to have a broken leg than a bad sprain. Now, no person means that a sprain in itself is so serious as a broken leg. But the real explanation of the proverb is, that if you have a broken leg, it compels you to take the necessary measures for your recovery; but if you have a sprain, you go on using the limb till chronic mischief is established in it.

Now, more danger results to women from abortion in proportion to their numbers than from confinements. The reason is that women treat the illness too lightly; they do not lie up; they frequently do not apply for medical advice even till they are compelled by some of the bad symptoms that follow their neglect.

In case of an abortion, however early, a woman ought to look upon it as a confinement. She ought to lay up—it need not be so long—as after a delivery at full time. Still she ought to keep her bed a full week after an abortion. It is important that measures be taken to make sure that the whole of the abortion comes away.

The discharges therefore ought always to be retained and shown to the doctor.

The chief dangers from abortion are bleeding and fever at the time—exhausting bleeding afterwards, if the abortion does not come completely away; and sometimes permanent enlargement of the womb, with excessive flow at the periods, and whites between the periods. As these evils are usually preventable by due rest and care, you will see how important it is to give that care, and take the necessary rest.

MORNING SICKNESS, with vomiting, is an affection that is apt to torment the pregnant woman greatly. It usually comes on at the end of the first month, and continues till mid-time. It is sometimes so severe as to be fatal; at other times it is entirely absent. The measures in your own power to limit its evil effects are—attention to take such food as is light, such as white fish, fowl, tripe, rabbit, beef-tea, chicken-tea, toast without butter. The food should also be taken frequently, in small quantities at a time, so as not to distend the stomach, as this greatly predisposes to vomiting, and at such periods as the patient has noticed the vomiting to be least annoying. If the patient vomits in the morning, and at no other time, food should be delayed till afternoon and evening. If the patient vomits during day, and never at night, food should be taken at night only, and so forth. For medicinal treatment and in serious cases, a medical adviser ought to be consulted.

BLEEDING IN LATTER MONTHS OF PREGNANCY.—In the latter months of pregnancy bleeding of a serious nature is apt to come on. Under such circumstances, a patient is bound to acquaint her medical adviser, so that proper steps may be adopted for its arrest.

CONSTIPATION.—Women during pregnancy are apt to suffer from troublesome constipation. It is dangerous for them to use strong medicines at this period. Among suitable laxatives may be named castor oil, compound liquorice powder, or Christison's pills, &c.

Patients may also expect piles and varicose veins of the legs during pregnancy. They are not to be alarmed regarding them. They usually pass off after delivery.

Confinement and Lying-in Period.—At her delivery every woman needs medical care and nursing. She cannot then do without assistance in some form or other, so that I need not remark upon this subject further. But I must be forgiven if I make some observations upon the time of getting up, as it is a matter in which the women of the working classes are particularly tempted to err, and in which they do go wrong.

Our well-to-do ladies may safely be left to their doctors and nurses.

But the wives of our working men are most unfortunately placed. Their scanty means preclude them from easily procuring the necessary nursing, and as they frequently feel pretty well they come to think that they should at once be up and attending to their household duties.

But I want them to put the matter before themselves in this way :—

Whether is it better to rest a little longer at a lying-in period, even although great inconvenience should result therefrom, provided the mother is certain to rise from her bed healthy, vigorous, and able to be useful to her husband and family, or to get up too early with a certainty of becoming more or less of an invalid for life? How is it that the women of our working classes age so rapidly compared with those in the better classes, and even compared with their husbands? That they do so is unquestionable; for you frequently see a working man's wife at thirty look like a woman of fifty. We obstetricians know that the great majority of such patients suffer from the evil effects of getting up too soon after their confinement.

It is not the direct results of the labours, but the indirect results of them. Getting up too soon induces enlargement of the womb, with excessive flow at the monthly periods, and exhausting white discharge between times; whilst, along with these dragging feelings, down-bearing pains, back-ache, and other miseries render the woman's life a burden, and greatly mar her usefulness.

Now, no doubt, poor women are often compelled to rise too soon after a confinement, from having no one else to attend to their duties. But I am satisfied many others frequently err through ignorance, being unaware of the necessity of rest and quiet for a lengthened period. As far as regards the first class I can say nothing. We all in our turn must yield to the inevitable. But to those who ignorantly or thoughtlessly expose themselves to these risks I want to say, with all the earnestness I can summon, Consider the consequences. Don't heed the common delusion that a patient ought to be able to get up on the ninth day.

On our better class patients we insist that they should remain strictly in bed a fortnight, move from bed to sofa for another week, and get from the bed-room to the drawing-room the fourth week. After that we let them out for a drive. These are by no means too great precautions.

Remember that after delivery a woman's difficulties are in a great measure only beginning. The womb and connected organs need time and rest to return to their original state. The natural changes are very apt to be interrupted by any careless exposure or exertion. It takes from six weeks to eight weeks for the womb, &c., to return to the normal condition after labour, consequently a patient can never remain in bed too long.

Food when Nursing.—The best adjunct to a patient's food when nursing is milk. It is a mistake to think that porter or other alcoholic drinks are needed. I have seen much harm done by their use when taken in this way. Women, when nursing, should avoid food that disagrees with their stomachs and induces indigestion, but otherwise no fixed rule is to be observed in regard to the nurse. In my opinion women trouble themselves far too much on this point.

Over-lactation, or Nursing too Long.—This is a common and disastrous custom. It often permanently unhinges a woman's health. The child should be weaned by the end of the ninth month at most. It is a mistake to think that nursing necessarily prevents a woman from again conceiving. If she does fall pregnant while nursing, the double strain on her system is apt to be specially injurious. The usual symptoms of over-lactation are liability to headaches or flitting neuralgic pains over the body, giddiness, palpitation on slight exertion, attacks of blindness, with noises in the ears, and a tendency to get faint. Such feelings are evidence that the woman is suffering from nursing too long, and that she ought to stop giving suck—this is, of course, quite independent of the actual period the mother has given milk.

HOW TO KNOW WHETHER A MOTHER PROVES A SUITABLE NURSE.—The question as to whether a mother is fit to nurse, or gives good milk, depends upon the effect of nursing upon the child. If the child does not thrive upon its mother's milk, gets ill, takes diarrhœa and wastes away, then, in the interest of the child, nursing should be given up, as, in that case, the mother's milk is clearly deficient. But such cases are very uncommon.

QUESTION OF NURSING WHEN MENSTRUATION COMES ON. — This matter puzzles mothers greatly. Is a mother to cease nursing when she sees the monthly periods return? My advice is to watch the effect on the baby and on the mother. If the child thrives, and is not made sick by the mother's milk when the monthly flow is on her, then, so far as the child is concerned, matters may be left alone. The problem then is to be solved in relation to the mother only. If the monthly flow returns only once or twice, then the mother may go on nursing; but if it continues regularly to recur, then she ought to wean the child, if the symptoms of too prolonged lactation already referred to manifest themselves, but if her health keeps perfectly good she may be allowed to nurse till the child is eight or nine months old.

HOW TO MANAGE IN PUTTING AWAY MILK.—The best plan is to put the woman on a very dry diet, allowing only a small amount of fluids of any kind, and to put on belladonna plasters on the breasts. I wish you particularly to avoid the injurious practice, so frequently adopted, of taking strong purges at this time. That kind of treatment very unnecessarily weakens the patient and does no good.

One point now, and I have done.

Change of Life comes to most women from the forty-fifth to the fiftieth year. In some cases the flow stops suddenly—in most cases it becomes irregular in amount and recurrence for a year or more. About this time women must expect to experience certain somewhat distressing sensations. Among the most common of these is a frequent liability to attacks of heat, followed by profuse perspiration and ending in a feeling of chilliness. There is often also a sense of fulness in the head, palpitation, and general discomfort. Patients ought to bear these facts in mind to save them from unnecessary alarm. Women should also know, that about this time important diseases are apt to become developed, and ought to take prompt measures to obtain medical advice when any unusual symptoms annoy them, in case they may by delaying too long, allow themselves to get beyond the reach of human help.

APPENDIX.

"*HINTS TO WOMEN REGARDING THEIR HEALTH, HABITS, OCCUPATIONS," ETC.*

1. THE YOUNG GIRL.—2. THE YOUNG WOMEN.—3. THE MOTHER.

The Young Girl.—It is of the first importance to form regular and proper habits, framed according to the laws of health.

From birth upwards, the female possesses special instincts and peculiarities that necessitates corresponding attention from those who wish to bring a girl up to be a healthy and useful woman or mother.

Much of the misery and many of the deaths of married females, depend upon deformities of the bony plevis, or want of symmetry in it. These deformities are in a great measure preventable if due care is bestowed upon the nutrition and management of very young girls, especially upon the avoidance of rickets, or the proper management of that disease.

It is of importance also that young girls should not be burdened with too heavy loads or too great toil, till their bones are properly hardened and matured.

Out-of-door exercise, plenty of romping, running, calisthenics, and so forth, ought to be much more inculcated upon young girls than is usual, in order that their organs, such as the heart and lungs, shall be well developed, and their muscular system strengthened.

As the emotional and imaginative nature of girls is particularly sensitive, great care should be taken in the education of girls not to over-stimulate those qualities of their minds, in case we have morbid reactions, commonly grouped under the name of hysteria, developed.

The Young Woman, as she passes from girlhood to womanhood, ought always to command the careful attention of her female friends. She ought to be apprised by them of the approaching monthly flow before it appears, to avoid unnecessary alarm and distress on the girl's part.

The monthly flow, when everything is right, ought to be without distress or pain.

Pain of a certain amount is very common : and in many cases there are pain and distress throughout life connected with the periods, rendering the woman's whole menstrual life miserable.

As this is much more apt to occur if the first two or three periods are neglected in the girl, it is necessary that these be carefully attended to.

The causes of all others most apt to induce painful menstruation are—

1. Weak health, with a nervous temperament.
2. Congestive or inflammatory affections of the womb, or parts adjoining it.

We must endeavour to overcome the former causes by careful attention to the physical and moral training of the girl, so that when the crisis comes she may meet it with, as far as possible, a sound mind in a sound body.

Inflammatory and congestive conditions are much in a woman's own power. They are developed through want of care or over-exertion, or exposure at or near the periods ; and every girl ought to be instructed to avoid inducing them, by practising the necessary care at and near the periods, particularly during the first few periods.

Women need to take unusual care of themselves at these times throughout their menstrual life.

In case of painful menstruation, the best simple treatment is to put the feet in hot water and mustard for a time—or to use a hot hip bath—apply poultices over lower part of the belly—and to take hot drinks.

In very severe cases a doctor ought to be consulted.

Stimulants should never be taken to allay the pain of a period without medical advice, as their use is exceedingly apt to lead to the habit of drinking.

Women ought to be exceedingly careful of falling into this vice, as the opportunities of seclusion they possess form a temptation greater than men usually have for indulging in secret drinking.

It is also more difficult—whatever be the explanation of it—for a woman to return to the path of sobriety, once she has left it, than for a man.

Strong medicines ought to be avoided during the periods. Personal cleanliness is specially required then.

Stoppage of the Flow.—Women are apt to over-estimate the importance of this occurrence, and to pay attention to the arrest of the flow, to the neglect of more important matters. The mere stoppage of the monthly flow itself can do no harm—it is merely a little blood.

If the woman has not been exposed to cold, so as to cause inflammation or congestion of the parts, and if she is not pregnant, then the stoppage of the flow ought always to direct the attention of the friends to her general health.

The arrest may be from poverty of blood, when the girl needs iron and cod-liver oil. It may be from threatening consumption of the lungs, when it will be accompanied by a dry cough, and the girl needs good food, good air, and cod-liver oil. It may be from some other disease of important organs, such as the kidneys and the bowels, and should always lead the patient to consult a doctor. Any severe acute disease, such as a fever or an inflammation of the chest, is apt to stop the flow for a time or two.

Excessive flow at the periods arises from various diseased conditions, and ought to lead the sufferer to consult her medical adviser, as it is very weakening.

Tight Lacing is an exceeding pernicious habit among young women. It replaces the beautiful outlines of the female figure by artificial distortions, and therefore produces ugliness. It interferes with the action of the chest, compresses the liver, and displaces it: interferes with the action of the heart, and displaces it; it tends to induce displacement of the womb, and other contents of the abdomen ; to cause rupture, piles, varicose veins of the lower limbs ; and, putting extra work upon the heart and lungs, leads to imperfect nutrition and development.

It is false in taste, false in physiology, and mischievous in its results.

It ought never to be practised.

Wearing too Thin Clothing.—This is a cause of great injury to young women. Many will not be induced to wear sufficient clothing from false ideas as to beauty. Others cannot afford both good substantial clothing and showy dress, and prefer the latter, though it injures their health.

In our climate, in the winter months, every woman ought to wear flannel next her skin. In this way the evil effects of cold in the chest, of rheumatic fever, inflammatory conditions of the kidneys, womb, etc., are best avoided. Women are often guilty of bringing on themselves consumption of the lungs or rheumatic fever, and, through its means, hopeless disease of the heart, by want of care in putting on warm clothing when they are exposed to cold.

The use of a sewing machine driven by the foot, should be avoided by women having any tendency to disease of the womb.

Girls who, in earning their livelihood, are compelled to spend a great part of their time sitting, should take every opportunity to overcome the evil effects of this by open-air exercise.

Habitual Constipation is particularly apt to distress women, and tends to induce womb disease.

As far as possible it should be mastered without the use of purgatives. Among the means that may be useful, regular exercise—systematic use of a cold bath each morning—fruit at breakfast—porridge eaten with treacle—a glass of cold water at night or in the morning—whole wheat boiled to a pulp and eaten as a pudding—also occasionally an enema of cold water. Regularity in attending to the calls of nature is also of importance. If all these measures fail, then some mild laxative should be employed. The compounds of aloes, such as Hamilton's or Christison's pills, are the best, as they do not constipate afterwards. Salines, such as Epsom salts, should be avoided, as they constipate after they have acted.

THE MARRIED WOMAN AND THE MOTHER.—*Pregnancy*—A woman during pregnancy should live as usual, only she should take special care of her movements, particularly till after the end of the fourth month, and again in the last two months, in case she induce abortion or miscarriage.

Abortion takes place in about one in ten of all pregnancies.

Many causes of abortion are beyond a woman's control.

But some of them, such as lifting heavy weights, jumping from a height, jerks and jolts of the body, over-exertion, and so forth, she may avoid.

Women ought to know that ill-treated abortions often lead to the entire ruin of health, and ought to regard an abortion as a delivery, keeping their beds for at least a week after it.

They should retain what comes away to show it to a doctor, as it is important that the whole abortion should be removed, in case if part be retained it may lead to future complications.

The dangers that flow from ill-cured abortions are—much bleeding for long periods afterwards—permanent enlargement of the womb—excessive flow at periods, whites between them, and chronic ill health.

These are avoided by care at the time.

Constipation is apt to be troublesome during pregnancy, but should only be treated by very mild measures.

Lying-in Period.—Patients are apt to get up too early, especially the wives of our working men.

In this practice very many evils originate. It is much better, at whatever inconvenience, to take the proper rest and quiet after delivery, than to bring on ill health and impaired usefulness for life.

It is chiefly on account of the evils resulting from getting up too early after confinement, that the women of our working classes age so rapidly, compared with those in better circumstances.

It takes six to eight weeks for the womb and parts connected to return to their normal condition after delivery.

Consequently, special care is needed during this entire period.

Too long rest cannot be taken after delivery.

The chief evils that result from neglect after confinement are chronic enlargement of the womb—excessive flow at periods—whites between periods, dragging feelings in the loins, back-ache, displacement of the womb, and general ill health.

Nursing.—The best element in a woman's food who is nursing is cow's milk; that is much better than porter or wine.

Nursing too Long is very exhausting on women. It should not be practised. Nine months are quite long enough to nurse.

Giddiness, tendency to faint, neuralgic pains through the body, headache, palpitation, and general feeling of illness, are the chief symptoms of nursing too long, and should make a woman wean her child.

Nursing in relation to Menstruation.—If a woman menstruates once or even twice during nursing, and the baby is not thereby made ill, there is no use stopping the suckling. If menstruation continues throughout the nursing, and the child is found to thrive, then the woman should stop nursing only if her own health is found to threaten to give way, in the manner above described in connection with nursing too long. But if her health keeps good and the child thrives, she may go on nursing till the end of nine months.

Weaning.—At weaning do not use purgatives, they are injurious. Take food specially dry, and put on a couple of belladonna plasters on the breasts.

Change of Life is apt to be associated with certain disagreeable feelings, particularly those of heat and cold, also with irregularity of menstruation for lengthened periods. These a woman is to expect, and not take alarm from. Women should know that important diseases are apt to arise at this period of life, and ought not to unduly postpone applying for medical advice if any untoward symptom supervenes.

ON THE REARING AND TRAINING OF THE INFANT AND CHILD.

By Dr C. E. UNDERHILL.

On the Evening of Saturday, 15th January, Dr Underhill delivered the seventh of the Course of Health Lectures in the Free Assembly Hall, his subject being "On the Rearing and Training of the Infant and Child." Dr Underhill said :—

Ladies and Gentlemen,—

You, all of you, or at least most of you, read your newspapers. You may have noticed every Monday, down in an obscure corner of your paper, a list containing some names and figures, and called "Health of the City." In it are recorded the numbers of births and deaths which have taken place during the past week, and some of the causes of the deaths. Besides this, there are mentioned the numbers who die at different periods of life. And this is the point to which I wish to draw your attention; for, if you take a number of weeks running, you will find that nearly half of those who die are children under five years of age. Thus, in the month of September last, forty-five out of every hundred who died were children under five years of age; in October, forty-two out of every hundred; and in November, thirty-seven out of every hundred: on an average, nearly forty out of every hundred.

Just think of that, not much less than half of these sad records are made up of the lives and deaths of little children who cannot help themselves; when they grow older, and can take care of themselves, the numbers are very different, but as long as they have to be left to the care of others, their chances of living are much smaller. And so it is in large towns all over Scotland—and all over Europe, too, for the matter of that—week after week, month after month, you may read the same painful story.

Now let us stop one moment and see what this means. It means that hundreds upon hundreds of children who are born into the world for the most part strong and healthy, are allowed to droop and die before they have got over the helpless period of childhood; it means, only too often, want of care, want of knowledge, and want of means on the part of their parents. For the loss of very many of these little ones is due to preventible causes.

Some of them die from diseases of the stomach and bowels, many a time brought on by improper food; others from those of the chest, which are frequently due to neglected colds, scanty clothing, and careless exposure to extremes of weather; and many more fall victims to the long list of fevers, and other catching diseases, which might be rendered much less frequent if we all tried our best to prevent them from spreading; by isolating the sick as soon as possible, and by trying to prevent your own children from catching them *from* others who are infected, or from spreading the diseases *to* others, if your own have any of them, in the manner which will be explained in one of the later lectures. I need only say here that these fevers are commonly spread by allowing healthy children to run about and visit or play with those who are sick, or just recovering from them: they might as well be allowed to play with fire. Another most dangerous practice, and one which is only too common, is allowing those who are convalescent to mix with the healthy before they are thoroughly recovered; they carry the diseases with them, and thus sow them broadcast. They are thus a serious cause of danger to the community; and they are also, as I shall show further on, exposing themselves at the same time to a terrible risk.

My object to-night is to try to tell you how to feed, and clothe, and care for your children, so that you may bring them up healthy, strong, and useful; and to give you some advice as to how you may avoid some of the evils and dangers which help to cause the dreadful mortality I have just described.

First of all, then, there are some hints which may serve for children of all ages; and though I dare say you know all about them already, you must bear with me if I mention things which everybody knows about, but which everybody does not put in practice. More mistakes are committed, I verily believe, and more lives lost, from want of care than from want of knowledge. One of the most important things to attend to is *warmth*. Children, and especially very young chidren, are extremely sensitive to cold; they feel the changes of the air, from warm to cold, and from cold to warm, much more severely than older persons do; the cold frosts of winter and the east winds of spring are very apt to bring on colds and coughs which may end in serious disease; and, on the other hand, very great heat is equally bad for them, and also may make them ill, though in a different way; diarrhœa and convulsions always increase in frequency as the weather gets hotter—it is therefore very important to attend to the proper dress and clothing of your children. Now I must beg you to get rid at once of the great mistake of thinking that children have great power of resisting cold, and that they are strengthened and hardened by exposure to it. There is no more serious error, there is none attended with more fatal results; and this belief is unfortunately a very common one; you cannot be too often or too strongly warned against it. The clothing of a child should be enough to keep it warm at all seasons, it should have more and warmer garments in the winter than in summer, and the winter clothing should be put on early in the autumn and continued until late in the spring. And remember, the most trying and dangerous days are those in which the wind is high, particularly when it blows from the north and east. The best material for the inner garments is flannel, and they should be made so as to cover the upper part of the chest and neck, so as not to leave these most delicate parts exposed to cold blasts. A neglect of this is a very frequent source of bronchitis and croup, and may serve to sow the seeds of consumption. If there is any tendency to diarrhœa, a flannel binder should be worn round the bowels. But the clothes must not be made too tight, they should fit loosely and easily, and not put any restraint upon the free movement of the limbs and body. Full room must be allowed for growth, which is constantly and rapidly going on; they should be made so as to be put on and off easily, particularly for the young babies and infants who get cross and irritated if the process of dressing them takes too long. Avoid altogether the use of pins—a needle and thread or a button does much better. Many a time have I seen a child in a violent fit of crying, for which no cause could be given until on coming to undress them, a carelessly placed pin has been found scratching the skin and causing pain. In cold weather, long drawers and stockings keep the skin well protected, but the latter should never be fastened with garters, which bind the skin too tight and always do harm. This remark applies, by the way, quite as much to grown-up persons also. Garters are an unmitigated evil. While not tight enough to impede the flow of blood into the leg and foot, they are sufficiently tight to interrupt its free flow back again through the veins; and thus they tend to produce swollen feet, and the swollen and varicose veins which are so common in women. To the eye of a medical man they are simply a relic of barbarism. Change the clothes every day and keep them as clean as possible. Whenever any of the garments is wet or dirty change it. Wet and dirty clothes are a constant source of skin diseases.

Another fruitful source of disease is *dirt*. Dirt in your houses and dirt on your children. Dirt has been called "matter in the wrong place:" it is very much in the wrong place when it is on the skin of a child. Therefore keep your children clean, and keep their clothes clean and tidy. They look much better and are much healthier for it. Of course when they are old enough to run about they will soon make themselves dirty again, but soap and water are cheap, and the little extra trouble is well repaid in the health and comfort of all. Never put a child to bed dirty. Don't be satisfied as too many are with washing their hands and faces; the whole body should be washed every day. Young babies and infants should be bathed and well washed every morning in warm water, and thoroughly well dried afterwards. As they grow older, the water need not be so warm, but it should not be quite cold during the cold weather. In summer cold water is best. The bathing should not be done too soon after a meal, never within an hour. This caution is specially needed by boys; who are apt, in the summer, to run off, as soon as they have bolted down their dinner, to get a bathe or perhaps a lesson in swimming in the nearest available water. Bathing too soon after meals is a serious mistake; it is almost sure to disorder digestion, and may cause cramps and other serious mischief. Young infants are best washed after their first meal, older children before breakfast. How important a clean skin is we see when we think of the vast amount of insensible exhalation of gases, and perspiration of fluids which goes on night and day through its pores; if not washed away, this perspiration dries and remains on the skin, chokes up the pores and sets up an irritation which frequently ends in some positive skin disease. We are too apt to forget that the skin is one of the three organs by which the effete products of decomposition are carried off from the blood. The kidneys and the lungs being the other two. The little pores with which we are all familiar are the mouths of minute sweat glands, of which it is calculated that there are about two thousand eight hundred, on an average, on every square inch of skin all over the body. When these are partially closed by dirt or disease, more work is thrown upon the other organs, and this leads to a derangement of the general health; if they were totally closed, by varnishing or painting the body all over, the child would very shortly die—it would die as surely, though not quite as quickly, as if a cord were tied round its neck and all breathing put an end to. Be sure and dry the skin quickly and thoroughly, rub it briskly, and don't leave off until it is perfectly dry; a half dried skin is sure to be made rough and sore very soon by the wind. Besides, the daily morning wash is a stimulant and tonic to the whole system which helps to make it vigorous and healthy. It is particularly necessary to attend to the cleanliness and dryness of the napkins which are used to a baby, the discharges which come from the bowels and bladder of a baby are very irritating, and if a wet and dirty napkin is allowed to remain applied to the skin it soon makes it sore, the skin gets red and inflamed and peels off, and these sores take a long time and much care to heal. They are easily prevented by proper care; it is the old story of a "stitch in time" saving a good deal of sewing afterwards.

If possible of even more importance than cleanliness *are fresh air and exercise.* If there is one thing more certain to produce disease and prevent the healthy growth of a child than another, it is breathing impure air. We all live and are able to grow by taking air into our lungs and food into our stomachs—but we only need food every two, three, or four hours, or even seldomer, while we have to take in air fifteen or twenty times a minute all our lives—if this process is stopped for a minute or two we die. Now you all know how much discomfort and disease is produced by one unwholesome meal, and just think what must be the result of a constant or prolonged breathing of unwholesome air—and by unwholesome air I mean mainly air which has been breathed before and has thus become foul and unfit for use—and the worst of it is, that breathing impure air does not produce such immediate ill effects as taking an unwholesome meal, and so we are apt to overlook it; but none the less does it, little by little, undermine the health and sow the seeds of disease. The commonest cause of consumption and scrofula is foul air. A great doctor, the late Sir James Clark, has said only too truly, "If an infant, born in perfect health and of the healthiest parents, be kept in close rooms, in which ventilation and cleanliness are neglected, a few months will often suffice to produce consumptive disease," that is to say to throw it into a decline. You can see when a child has had an unwholesome meal, because it has pain and vomits, or has diarrhœa and is feverish; it tells its own tale at once; and you can see, though less quickly and easily, when a child breathes unwholesome air, because it grows up pale, and thin, and puny, it loses appetite, suffers more than ever from cold, sits by the fire and takes no interest in its work or play, and soon developes a cough which is often the earliest sign of serious disease.

To escape from these evils, children should be out in the air as much as possible; babies should be carried out every day when the weather is fine—this may be done in winter if the child is warmly wrapped up and protected from the wind—but, at the same time, the mother who carries out her child must not stand about gossiping at the corner of the street, and forgetting that all the while the keen wind is exposing the child to risk; in this matter common sense and carefulness are the best guides. Open the windows freely while the children are out of the room. The sleeping-room is the one most needing ventilation; try and realise and keep in mind that foul air is poison to young and old alike—it may be a slow poison, but it is a very sure one. Older children ought to be in the air all day long in the summer, and whenever it is fine in the cold weather. Take especial advantage of *sunny* days. Children require sunlight as much as fresh air to make them grow healthy and strong. Have you ever tried to rear a plant in the dark? If you have, you know that the stems grow long and thin, and weak and white, and never gain their proper colour—and so it is with children. If your rooms and houses are dark and out of easy reach of the *sun*, it is all the more reason for letting your little ones be out when there is light and air in plenty. A healthy child will play about and keep itself warm. One word of warning, however—colds are often caught by letting them lie or sit down on the ground or the grass when it is cold and wet, or stand about in a wind when they are perspiring; in this way, what should be a blessing may turn out a curse.

One word as regards exercise—don't be in too big a hurry to teach a child to walk; lay it on its back and let it kick about as much as it likes while it is very young. A little later it may crawl and creep about in perfect safety, but when a child is made to stand before its legs are strong enough to bear it, they are very likely to give way and become bent—the body is too heavy for the weak bones of the legs and they become deformed. I see scores of such at the Children's Hospital; the more they stand and walk the worse they become; and the only way to prevent this from happening, and to cure it when it has happened—for it generally can be cured with care—is not to let them be on their feet until they are stronger.

Another thing quite essential to the health and growth of a child is *sleep*—and there are some points about this worth attending to. Children require much more sleep than grown up persons. They require to be kept very warm when sleeping; the natural warmth of the body is less during sleep than at other times; the hours of sleeping should be made quite regular: this is easy to manage if you begin with a baby at once; they soon acquire regular habits, and in the matter of sleep and feeding, this regularity of habit cannot be begun too soon: a bad habit is difficult to break.

For the first few weeks a baby should sleep almost constantly, only awaking at regular intervals to be fed. After the first two months it lies awake longer, and is fed less often—it should then be put to sleep for at least two hours in the forenoon, from ten till twelve or thereabouts, and again in the afternoon for at least an hour. But too much sleep during the day at and after this time spoils the rest at night, which is the most important time for rest. For the first month a child is better to sleep with its mother, after this it may be put into a crib, but never cover its face with a handkerchief, and never have curtains to your crib—they cause the child to breathe its own air over again and always do harm. The crib must be put in a warm place, out of the draught, and there should be plenty of warm bedclothing. But observe this—when you see a young child constantly kicking off the bed-clothes at night, and especially if it be found freely perspiring about the head, watch it carefully—there is sure to be something wrong with it: these are among the earliest signs of the serious disease called rickets. Take care to keep the bed-clothes clean, sweet, and dry. Older children should be allowed to sleep an hour before dinner up to the fourth or fifth year, when it may be discontinued. Put them to bed at night early—between six and seven o'clock, and they will generally sleep twelve or fourteen hours. Never wake a child suddenly—the change from sleeping to waking should be gradual. When a child awakes in the morning it should not be permitted to lie long in bed; take it up and dress it, and so you may get it into the regular, healthy, and most valuable habit of early rising.

After the child is up don't immediately make up the bed again, as is too often done, but let the mattress be shaken well up, and have the sheets and blankets thrown over the back of a chair or off the bed, and exposed to the air for an hour or two, that they be thoroughly dried and ventilated. Open the window freely.

We now come to the question of *food*—the most important of all. How is a child to be fed? More harm is done, and more lives are lost from improper feeding of the young than in any other way. And this is the case, in spite of the fact that nature has supplied, ready to hand, and in plentiful quantity, the best of all foods, the milk in the mother's breast: and as this is the natural food, so it should be the model which we are to imitate, if it be necessary from any cause, to give the children some other food in its place. Every mother should make it her duty, as it is her privilege, to nurse her baby at the breast. The only exceptions to this rule are those cases in which, because of special delicacy or disease, they are forbidden by the doctor to do so. Whenever, from any cause, the child cannot be brought up on the breast, the only food which should be given to it for the first seven or eight months is milk: the milk of the cow or the goat. Milk is a compound prepared and supplied by nature, and contains all the ingredients that are necessary for the growth and nourishment of the child; and no other artificial compound can take its place. A child's stomach is a very delicate organ; it has not for many months the power and vigour necessary for the digestion of other kinds of food. This is specially true of the foods which contain much starch, such as cornflour, arrowroot, sago, and others; these starchy foods are not and cannot be digested by the young infant; they simply irritate the stomach and bowels; they are, in fact, an irritant poison, that is the proper name for them, while, at the same time, the child is being starved for want of the only food it can digest. It is one thing to fill the stomach with thick farinaceous food; it is quite another thing to get it digested so as to nourish the child.

The common result of such improper feeding is that it ceases to thrive, it begins to pine, grows thinner, cries a great deal with gripes and colic; it vomits a good deal of undigested matter, the bowels become loose, and a diarrhœa is established, the stools consisting mostly of a thin, greenish, slimy, ill-smelling stuff; then to stop the crying and check the diarrhœa, soothing syrups, opiates, and other abominations are poured down its unhappy throat; artificial food and drugging go hand in hand, while the only means of stopping the disease and restoring the child to health—viz.: by withdrawing the cause of all the mischief—the indigestible food—is neglected.

It is sad to think of the loss of life which this most pernicious error causes. A recent writer* has put it thus: "The slaughter of the innocents in the days of Herod claims the attention of the historical student, and creates a feeling of horror at such barbarities; but the Herodian murder of infants is nothing compared with the thousands which are sacrificed on the altars of ignorance and fashion. The history of their slow sufferings and death is not written with the point of the sword in characters of blood;

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* Dr Benson Baker, in his excellent little book, "How to Feed an Infant."

they pass away silently, like snow as it thaws, and thus fail to attract general attention."

Now, the point I wish to impress upon you is this, that the only food suitable for a young baby is milk. It may be given in two ways, either from the breast of the mother, or from the bottle. The breast milk is infinitely to be preferred; but if she have not enough milk, or if her calling compels her to be away from her child during the day, it ought to have the breast at night. It is better to suckle the child at night than not at all. Let it have as much breast milk as possible, and only make up the deficiencies with the bottle. It is quite a mistake to suppose that mixing the two milks does any harm. The breast milk may be compared to gold, the cows' milk to silver; all farinaceous and artificial foods are base money. No man would be foolish enough to say, "If I can't have all gold, I won't have any; I don't like mixing the coins." Take all the gold you can get, and add the silver to make up the necessary amount.

First, then, as regards nursing at the breast. The child should be put to the breast early, within the first twelve hours. The first milk which comes is different from what comes afterwards, and helps by gently acting on the bowels to prepare the passages to properly digest the fully formed milk. Instead of doing this, nurses are far too apt to administer a dose of castor oil. It is very hard for an unconscious infant to begin life with a nauseous draught like that; and in ninety-nine cases out of a hundred, it is quite unnecessary and wrong. If the milk has not yet come, the act of sucking will help it; and if the child cries with hunger, a little weak milk and water may be given with a spoon. The milk, however, soon appears, and as soon as this is fully established, the child should be put to the breast *regularly* at stated intervals—every two hours during the day, and less often at night. By this regularity you gain two objects. You allow time for the one meal to be digested, and for the breast to fill again before another meal is required; and you begin the training of the child by teaching it regular habits. By carrying out this system thoroughly, you may make moral training go along with physical growth, and you render both mother and child healthier and happier.

The mother while nursing should take good food in sufficient quantity; but she should not be drinking all sorts of foods at all sorts of hours, under the idea that she will thus make more milk. She is more likely, in this way, to upset her digestion, and injure the quality of her milk. *The secret of good nursing lies in keeping in the best health possible.* Plenty of fresh air and plenty of rest, and a sufficiency of plain, unstimulating food are better milk producers than all the nostrums ever invented. It is also important to remember that any violent nervous excitement, such as anger, fright, anxiety, and grief are sure to react upon and distress the child. A sudden mental shock experienced by the mother just before nursing, or while the child is at the breast, has even been known to prove fatal to it. I would say, then, to mothers, "Cultivate a tranquil mind." It is better for you, better for your infants, and better for all about you.

The mother, if her health remains good, should continue to nurse her child for about nine months. No exact date can be fixed. If the child is thriving well, and has cut several teeth, and especially if the mother's health begin to suffer, the nursing should be at once given up. But if the mother is in vigorous health, and have plenty of milk, she may partially nurse him for a month or two longer. Beyond a year she should never go. Such prolonged nursing does harm to all concerned.

Weaning.—The child should be weaned, then, at or about the tenth month. It must be done earlier under the following circumstances. 1. If the mother's health is suffering, or if she is attacked by any acute disease. 2. If she becomes pregnant again while nursing the child. 3. If the child is insufficiently nourished upon the breast milk, and yet refuses to take other food. This happens when the milk is too thin and watery, although it may be in sufficient quantity. It thus ceases to be a nutritious food. The stomach is filled by a fluid incapable of nourishing the child but which satisfies the appetite for the moment, and prevents his taking a meal which would be really beneficial. You must watch carefully the actual condition of the child, and not rely too much on dates, or on the advent of teeth.

It is best to wean a child *gradually*, choosing a time when he is in good health, not feverish nor fretful with the actual cutting of a tooth. It should be done by lessening the number of times he is allowed to take the breast; thus giving him time to get used to and to relish the other food given him. Reduce him by degrees to one breast meal a day; and after about a week, this too must be given up. It is not advisable to wean suddenly, unless some sudden emergency make this course necessary.

But it is not among children brought up at the breast that the great and sad mortality of which I spoke just now is found; it is among those brought up by hand, or on the bottle. And it is to a great extent due to the wrong sort of food being put into the bottle.

A word or two about bottles. The old-fashioned bottles with a cork on one side are the best. They are the best (1) because they are the simplest, (2) because they are more easily kept clean and sweet, (3) because, when they are used, the child must be held in the proper half-upright position, the natural one for a child taking food, and the child is thus kept warmer.

We should aim, above all things, at making the food we put into the bottle as like as possible to the infant's natural food, its mother's milk—and the nearest substance we can get is cow's milk. But cow's milk differs in some important ways from human milk. It is less watery, it is less sweet, and, above all, it has a much larger quantity of casein. This you can see by the accompanying table:—

CONSTITUENTS OF MILK (in 1000 Parts).

	Water.	Sugar.	Casein.	Butter.	Salts.	Total Solids.
WOMAN'S MILK . .	889	43	39	27	2	111
COW'S MILK - - -	864	38	55	36	7	136

But the most important difference cannot be brought out by such a table; it consists in the different quality of the casein in the two milks. Casein is an albuminous compound which, when rennet or other coagulating substance is added to milk, coagulates and forms the curd you are all familiar with. Now the same thing happens as soon as the milk reaches the stomach—it curds; but the curd of the human milk is a soft, flaky substance, easily dissolved and digested. The curd of cow's milk so produced is hard and tough; it requires therefore to be given very much diluted, and we accordingly add more water to the milk than would otherwise be necessary, in order to dilute the casein more fully. So that in order to make the cow's milk as like the mother's milk as possible, we must dilute it with water and add some sugar to it. At first the proportions should be at least equal parts of milk and water, with a small quantity of sugar; if the milk be very poor, a dessertspoonful of cream may be added to each meal with benefit. And as cow's milk soon turns acid, a tablespoonful of lime-water in each bottle is often useful in making it agree better with the child. This is particularly advisable in warm weather. Two other cautions about milk:—Boil the milk intended for the child's use as soon as it comes into the house. When this is done, it does not go sour so soon; and the boiling destroys any injurious particles which may be in the milk. Where there is any doubt about the purity of the water, boil it too. After the first six weeks, the proportions should be two-thirds of milk to one third of water; and after the fourth month the milk may be given plain. *For at least the first seven months the child should have no other nourishment whatever.* But this not all. It is absolutely necessary that the bottle be kept clean. It is best to have two bottles to be used alternately, and the one of them not in use should be washed with hot water immediately after being used, and should be kept lying in clean cold water until it is wanted again. Many an attack of colic and diarrhœa is brought on by an unclean bottle. A very small quantity of milk left standing in the bottom of the bottle, or on the teat quickly turns sour, and a small speck of sour milk is sufficient to turn the fresh milk for the next drink sour too. Smell the bottle before you put a fresh meal into it, and if there is the least sour smell about either bottle or nipple, wash it until it smells fresh and sweet. A good nose is a very useful instrument in a nursery. Cleanliness, then, is one essential to health; regularity is another. The child should be fed at regular hours—every two hours during the day, and twice during the night, for the first six weeks: after this every three hours is often enough, but then the quantity of each meal must be larger. Never give a child a bottle merely to keep it quiet; you damage its stomach and its character at the same time. Don't forget, too, that the milk which the child sucks from its mother is warm, the milk and water should therefore be warm too, and as near the heat of the body as possible, *i.e.*, at or about 98° Fahrenheit. Cold milk delays digestion, and so injures the child. The position in which the child is held while being fed is of some importance—it should be put in the same half-upright position as it is in when sucking from the breast. If allowed to lie on the back, it gets the milk too fast, and this brings on indigestion and pain.

If good cow's milk cannot be got, the condensed Swiss milk is very useful, but it must not be given too strong; half a teaspoonful to a tea-cup of water is plenty to begin with. For the first four months it is an excellent substitute for ordinary milk, and most children thrive on it: but it does not do to continue its use too long.

The next question that arises is when are you to begin and give the child any other food but milk. The answer to this depends a good deal upon how the child is thriving. If it is fat and flourishing, and has cut several of its front teeth, at the age of seven or eight months, and no earlier, a meal of some farinaceous food may be given once or twice a day. Even now the foods which contain much starch are to be carefully avoided; the child cannot yet thoroughly digest them, such as arrowroot, sago, cornflour. The best farinaceous food to begin with is oatmeal gruel, well-boiled and strained; or, as a change, milk thickened with a rusk or well-baked flour. Chapman's entire wheat flour is an excellent food. It is to be preferred to ordinary wheat flour as it contains the phosphates of the wheat, and also the cerealin, a peculiar ferment which changes starch into sugar. It is prepared thus : Put a pound of Chapman's wheat-flour, tied up very tightly in a pudding-cloth, into a sauce-pan of water, and let it boil constantly for ten hours. When it is cold, the soft outside layer is scraped away, and the hard interior is reduced to a fine light powder with a fine grater. A teaspoonful of this powder is rubbed up with a teaspoonful of cold milk into a smooth paste ; a second spoonful of milk is added, and the rubbing is repeated until the mixture has the appearance of a perfectly smooth cream : a quarter of a pint of hot milk, or milk and water is then poured on the mixture, stirring briskly all the time, and the food is ready for use. Some of the artificial foods, which however are more expensive, are prepared in such a way that the starch is rendered soluble and easy to be digested. This is effected mainly by the addition of malt and the employment of heat. Malt, and of course barley from which it is made, contains a substance called *diastase*, which acts as a ferment, and helps digestion in the same way that some of the constituents of the saliva act on food—constituents which are not present in much quantity in the saliva and other secretions of children, until they have cut most of their teeth. The best of the artificial foods are Mellin's Extract, Nestle's Milk Food, and Savory & Moore's Food. But if oatmeal and plain wheaten flour agree with your children, stick to them. These meals should be given once, or, at most, twice a day ; but ever remember that the greater part of a child's nourishment should still be milk.

I must add that we do occasionally, but rarely, meet with children with whom milk in any form disagrees. This condition is generally the result, in the first instance, of improper feeding, or of over-feeding. From these or some similar cause an irritation of the stomach and bowels has been set up, vomiting and diarrhœa make their appearance, and the child begins to lose flesh. The hard curd of cows' milk which forms immediately the milk reaches the stomach, further irritates it, and the child gets worse. Such a case imperatively requires the aid of a doctor, and the greatest care is needed to insure recovery. Sometimes barley-water, mixed in equal quantities with the milk, will make it agree, by lessening and softening the curd; sometimes the whey of the milk, separated from the curd by rennet, and made richer by adding one part of cream, which contains no curd, to four of the whey, makes a digestible food. Occasionally it is necessary to feed them for a day or two on rice water, with the boiled rice pounded and mixed with it; but such cases are serious, and the advice of the doctor should be taken and very carefully carried out.

After the child has cut most of its front teeth—that is to say, towards the end of the first year, it may be given once a day a meal of a meat broth with barley in it, or of gravy and bread crumbs. The broth should be made by cutting up the meat finely and letting it stand for two or three hours in cold water and then boiling it. In this way much more of the nutritious juices of the meat are obtained than by simply pouring boiling water on it. At about the same time, or a little later, a lightly-boiled egg may be used instead of the broth, once or twice a week; or a well-boiled mealy potato, carefully mashed and mixed with good meat gravy. No solid meat food should be given to a child under two years of age, indeed, until it has cut all its teeth, and this for the very good reason that until its back teeth are ready for use, it is unable to chew and masticate such food so as to prepare it to be digested in the stomach. After this a little meat well-cooked may be given to a child occasionally; but it is not at all essential, and should not form a part of its every-day food. It is a great mistake to give children much animal food, particularly such as are weakly and delicate. For the first three years, it is not too much to say, the less they have the better. The best food is not that which contains the most nourishment, but that which is best suited to the state of the digestive organs at the time it is taken.

Whenever animal food is given, it should be minced very fine, and at first even bruised in a mortar, to take the place of mastication.

Bread and butter, oatmeal porridge, milk, rice, and light puddings are to form the staple of its diet. Avoid all stimulants absolutely, avoid tea, cakes, and pastry. The plainer and simpler a child's food is, the stronger and healthier will be its growth. And teach your children to eat slowly; bolting the food is a sure way to beget indigestion and stomachache. Children should only be allowed to eat at meal times, and should have nothing between them.

To sum up the advice I would give you about feeding a child.

Feed it regularly; have all food and bottles scrupulously clean; rely on milk and milk alone for the first seven or eight months—avoid starchy foods, regulate the time for adding to the food by the appearance of the teeth, and the way in which the child is thriving—and remember that the great error in rearing children is over-feeding.

There are one or two other points on which I should like to make a remark or two before I close. One of these is *teething*—and I may remind you that the number of first or milk teeth which a child gets is twenty; and that they come for the most part in a very regular order, and at pretty definite intervals. Now, the eight front teeth, four above and four below, are called "incisors;" the eye teeth, two above and two below, are called "canines" or "eye teeth;" and the eight back teeth, two above and two below on each side, are called molars or grinding teeth. The order in which they ought to come when a child is thriving and vigorous is as follows:—first the two lower middle incisors; these appear at about the seventh month, seldom earlier; they are followed in a few weeks by the two upper middle incisors; and almost immediately afterwards, the other two upper incisors, one on each side of the middle ones—a week or two later the two other incisors in the lower jaw come through, so that all the incisors generally appear before any of the other teeth; and the incisors being smaller than the others are generally cut without much trouble, and by the end of the tenth or eleventh month—after an interval of about two months the first four molars begin to appear, and they take about two months, more or less, to make their way through the gums. After another interval of two or three months the eye teeth begin to appear, and they are fully cut by the end of the eighteenth or twentieth month—this is followed by another period of rest, after which the four back molars come, and soon after the end of the second year the first dentition is complete.

Now, a child in perfect health usually has its teeth in this regular order, and at the times I have just mentioned, and without necessarily undergoing much suffering. For teething is a natural process. Yet the period in which the teething is going on is one of more than ordinary danger to the child, but not only, and not chiefly, on account of the teeth. It is a time when growth and development are most actively going on; it is a time of change from one mode of living to another; that is to say, from a purely milk diet to one of a more solid character, and which requires chewing and a more active digestive process; it is a time when those organs and functions are getting into order, by the due action of which the body is nourished and built up.

When a child is teething, then, it requires more than ordinary care, you must watch its general condition; see that its bowels are kept in good order, rather too loose than too confined—let it have abundance of fresh air, and avoid making any changes of diet just when the teeth are coming through the gums—cooling drinks of water, or milk and water, or barley water, are useful to allay the thirst, and cool the hot mouth—a warm bath at night relieves the feverishness which is often present—and if the gums are swollen and inflamed, it may be necessary for the doctor to lance the gums—this gives very little pain, is followed often by great relief, and not unfrequently wards off a convulsion or other serious trouble. A quite unnecessary prejudice exists against this little operation, which is quite harmless, and may be productive of great good.

"The difficulties and dangers of dention may be reduced to a minimum by judicious diet and a strict observance of the conditions of health. It is of the first importance that the child should have a plain, unstimulating, mostly milk, diet; and that it should be most carefully protected from cold and damp, for children are, at this time, if exposed to these influences, more liable to suffer from inflammatory diseases of the chest and air passages." In the earlier stages, while the teeth are "breeding" in the gums, the irritation may be relieved by gently rubbing them, or by giving the child a crust or an indiarubber pad to bite at; but shortly before they break through the gum the mouth is so tender that the child will allow nothing to go near it; and it is just at this time that the timely relief of lancing is of most service.

Bowels.—It is very necessary to attend to the condition of the bowels. When they go wrong, either by being too loose or too confined, we must generally look for the cause in the *diet;* and we must, accordingly, try and put matters right by making alterations in it, instead of by administering drugs to the child.

Diarrhœa.—If the child is on the breast, and the bowels become loose and slimy, the mother should examine carefully into her own condition as to food, exercise, and regularity of bowels and digestion, and correct anything she may find wrong there; if necessary, she should take a dose of castor oil or tincture of rhubarb, which will often set matters right. If, with all the attention she can give to her own condition, the child continues to suffer and begins to lose flesh, it is probable that her milk is unwholesome, and the child will have to be weaned, but before doing so she should consult her doctor.

In children brought up on the bottle, when the bowels go wrong, the strictest attention should be paid to the bottle and all that goes into it—see that it is perfectly clean and sweet, and free from the slightest sour smell. Get fresh milk twice a-day and raise it to the boil before using it; put barley water with the milk instead of water, and make the mixture weaker than before, and add to each half-pint two table-spoonfuls of lime water, or a few grains of bi-carbonate of soda;—give the child smaller quantities at a time and feed it oftener. See that the child's bowels and feet are kept warm, and put a flannel binder round the body—a sudden chill is a very common cause of diarrhœa. If in spite of all care the diarrhœa continue, send for the doctor at once, rather than give it drugs yourself.

Constipation is commoner in children brought up on the bottle than in those fed at the breast. The natural tendency of the bowels is to regular movement once or twice a-day. If the stools are hard and lumpy, and the movements irregular and not frequent enough, the child is probably being overfed,—the meals should be lessened in quantity, no lime water should be given; one meal a-day of thin oat-meal gruel may be substituted for one of milk, or a table-spoonful of fluid magnesia may be put into the food once or twice a-day. If the bowels are loaded, a tea-spoonful of castor oil is useful to begin with, but the frequent use of purgatives only does harm, and should be avoided. An injection of two or three ounces of warm soap and water often gives relief. Thirty grains of manna in a table-spoonful of distilled water is a harmless laxative, and may be repeated twice a-day for a day or two, till the motions become more natural. But the chief reliance should be placed on lessening the quantity and altering the quality of the food.

A word or two on *Vaccination.* By the law of the land every child must be vaccinated before it is six months old. Living at this time of day we find it difficult to realise the state of matters before this most invaluable means of lessening the ravages of small-pox was discovered. It is a rare thing now to meet with a person marked with small-pox. There has hardly been a case of the disease in Edinburgh for the last eight or nine years, and only those whose duty it is to nurse and attend the sick, know what a terrible disease it is. This is not the time or place to discuss this question on its merits; I only ask you to think how terrible a disease it must have been, when, shortly after a young and fair queen of England had died of it, it was thought safer to give a milder form of the disease itself to every child by inoculation, rather than let them run the risk of taking it in its more deadly form. By early and efficient vaccination we are almost perfectly guarded from this dread pestilence ; and it is the duty of every parent to see that his or her children have the benefit of this protection. I have had the opportunity of watching the course of more than one epidemic of small-pox : it was *invariably* caught first by those who had never been vaccinated : such were the first to suffer from it, and to bring and spread it to others ; and such were almost the only ones who died of it. I believe, and I wish all of you to believe, that *thoroughly efficient* vaccination is the one almost absolute safeguard against small-pox ; and if perchance one so vaccinated person in a thousand do take the disease, he is almost sure not to die of it. And I would urge on all the importance of revaccination once after the period of childhood has passed ; particularly if an epidemic of small-pox is threatened or actually present. If well carried out it makes the security well nigh perfect.

It is well to remember that children with irritable skins and of unhealthy bodies, sometimes have skin eruptions after vaccination ; but such eruptions are not caused by the vaccination ; they follow it as would and do follow any other irritation of the system, such as teething or an attack of diarrhœa. The best time to choose for vaccination is about the fourth month, while the child is fed entirely on milk and is in vigorous health, and before it has begun to be annoyed by the coming of the teeth.

Though we are not occupied on this occasion with the *diseases* of children, I cannot quite pass over one subject in connection with them, because it is so important. I mean the care that it is necessary to exercise when they are recovering from any serious illness. It is only too true that the children of the poor die of acute diseases, particularly measles, scarlet fever, and whooping cough, in far larger proportion than those of the wealthier classes. And the reason and the remedy are not far to seek. They are allowed to get up to run about and to expose themselves to cold a great deal too soon. The dangerous and fatal effects of cold on the sensitive skin and chest of children just recovering from these diseases cannot be exaggerated. Multitudes of those whose deaths are recorded from the three diseases I have named really die from secondary disorders, which may be prevented by all, and are prevented by those who are fully alive to the danger. *The* disease which follows scarlet fever is disease of the kidneys producing dropsy. *The* disease which follows measles and whooping-cough is disease of the chest and lungs, producing bronchitis or pneumonia. The one cause common to all these secondary diseases is, I repeat, exposure to cold. Therefore I exhort you most earnestly to see to it that you do not swell the ghastly list of mortality by allowing your children to suffer from this cause. Do not let your children leave the house or be exposed to draughts for at least a month after the onset of either of these diseases in cold weather, and even in the height of summer the greatest care should be taken to see that they are thoroughly recovered from the first two and are over the worst of the whooping-cough before they are allowed to be exposed to the weather. The same caution holds good in relation to recovery from all serious disease.

In conclusion, I would urge on all the importance of beginning the education of their children while they are in the cradle. The first lesson a child learns—and it cannot learn it too soon—is that of order and regularity—regularity in feeding, in sleeping, in lying awake. It is as easy to teach a good habit as a bad one, and the after-results are infinitely more satisfactory. Implicit and ready obedience comes next, and this requires only firmness, kindness, and good temper to enable it to be carried out with perfect success. If it be ever necessary to beat a child, choose some part for making the application where you can do no harm. To box a child about the head or pull its ears is not only cruel but dangerous. Beware of frightening children by silly and alarming stories of bogies and hobgoblins, and particularly by shutting them up in the dark: a sensitive and timid child has by such treatment many a time had its mind seriously and permanently injured. Above all, it is to be remembered that children are imitative animals, and will diligently follow, for good or for evil, the copy that is set before them. The influence of a good example in all relations of life will do more than anything else to bring up children as useful and happy members of society.

I have endeavoured in the foregoing remarks to put before you some of the principles which should guide you in rearing your children, and I have insisted most on those which are generally forgotten or overlooked. If they are common, simple, easy, every-day rules, there is all the less reason for neglecting them. It was once asked of old—"Did this man sin or his parents that he was born blind?" See that no man can ask of your little ones—"Did this child sin or its parents that it has grown up thin, and puny, and diseased?" There can be but one answer to such a question. I cannot conclude better than in the words of the great Hunter: "If you would have strong children, remember there are three requisites—plenty of milk, plenty of sleep, and plenty of flannel."

APPENDIX.

RULES FOR THE MANAGEMENT OF INFANTS.

1. *Warmth, Cleanliness, Fresh Air.*

Keep them warm: let the clothing be warm, but not tight. Wash them all over with soap and warm water daily, wiping them thoroughly dry afterwards. Give them plenty of fresh air: send them out, at least for a short time, every day that the weather is fine; and, while they are out, air the room, by freely opening the window.

2. *Nourishment while the Child is under Seven Months old.*

The mother's milk is the most natural, and accordingly the proper food for infants. Therefore, if the mother has plenty of milk, let her suckle her child and give it *nothing else* till it is seven months old. If the mother has too little milk, still let the child have what there is; and, in addition, cow's-milk and water, as directed in Rule 3. Till the child is seven months old, milk must be its *only* food.

3. *How to bring up "by hand."*

If the child *must* be brought up by hand, it should be fed with milk and water out of a bottle. At first, there should be nearly as much water as milk, but when the child is a month old, two parts of milk should be mixed with one of water: after this, the proportion of milk should gradually still further be increased, till, at four or five months, it is given plain. A teaspoonful of sugar should be added to each bottleful, and the milk and water should in all cases be boiled first. If, at any time, the milk seems to disagree, a tablespoonful of lime water should be added to each bottleful. *Give the child no other nourishment whatever.* A very large number of the children that are brought up by hand die in childhood; and this mortality is for the most part due to the practice of beginning too soon with corn-flour and such like foods. These are not proper nourishment for children under seven months old, and should never be given to them. While the child is under a month old, do not give it more than half a teacupful of milk and water at a time. The bottle should draw easily. It should be very carefully washed out after every time it is used. Then bottle, cork, and tube should be kept separately in a bowl of clean water till next time they are needed. If the bottle is not quite clean, the milk may sour, and may thus make the child ill.

4. *Importance of Regular Feeding.*

The child should be put to the breast *regularly:* for the first six weeks, during the day, in general not oftener than every two hours; afterwards about every three hours. During the night, it does not need to be fed so often. A child soon learns regular habits as to feeding. It is a very great mistake to give the breast to the child whenever it cries, or to let it be always sucking, particularly at night: this is bad for both mother and child. If the child is brought up by hand, it should be fed with the same regularity: never give it the bottle *merely* to keep it quiet. If the child is weakly, the intervals between the feedings must be somewhat shortened, both during the day and during the night.

5. *Nourishment when the Child is over Seven Months old.*

If, at seven months, the child is strong and healthy and has cut a few teeth, it may now have one or two meals a day of milk slightly thickened with good well-baked bread or well-boiled porridge. *It should still have,* besides this, *plenty of plain breast or* *cow's milk.* At ten months, it may, once a day, have a little meat-broth made with barley or rice, without vegetables. At twelve months, it should be taken from the breast. Till the child is two years old, no solid animal food should be given. *Even at two years, milk should still be the chief food.*

If, at seven months, the child is weakly or sickly, or is backward in teething, milk must remain the only food for some time longer.

6. *Avoidance of Stimulants, &c.*

Tea, beer, whisky, and other stimulants, cheese, fruit, and pastry, as also "soothing-medicines," "sleeping-draughts," "cordials," "teething-powders," &c., *should never be given;* and even ordinary medicines should, if possible, be given only after proper medical examination and advice.

THE USE AND ABUSE OF WATER IN HOUSES.

BY DR STEVENSON MACADAM.

ON Saturday Evening, 22nd January, Dr Stevenson Macadam delivered the eighth of the Course of Health Lectures in the Free Assembly Hall, his subject being "The Use and Abuse of Water in Houses." Dr Macadam said :—

The water supply of a house must be regarded as one of the principal factors regulating the health of the people residing within the house. In importance it stands side by side with the air supply. Both minister directly to the sanitary condition of our homes, and on the use and abuse of air and water depends much of the rate of sickness, as well as of the rate of death in every family, and especially in the younger or child members, who are influenced much more by such agencies. What takes place in a single house is practically repeated in collections of houses, in villages in towns, and in cities, so that the air and water supply of a town very much determines the sickness and death rate of that town.

The special subject we have to deal with to-night is the water supply—"the use and abuse of water in houses." My duty will be to show you the way in which you can use water so that it shall best act as your health friend, and how also you can avoid the abuse of the water, and keep it from being a deadly enemy.

As we are in Edinburgh, I will deal with water affairs as we have them here, but I must not neglect an allusion to country districts as well, where some of us may go for work or for play, or at least where most of us have friends.

Water is so common a substance, that we are apt to forget how necessary it is to healthy life. People will scarcely take the trouble to think about it. They hardly consider it worth a few moments' consideration, and when they do think about it, it is generally associated with operations external to themselves. It suggests to the younger portion of the population especially, washing of hands and faces; to others, washing of clothes; to others, washing of houses; and to others, mere cooking of food, such as boiling potatoes or eggs; but scarcely does it ever suggest that it is absolutely *food* itself, and that of the structure of the bodily frame water constitutes a very large proportion; in fact, about three-fourths of the entire weight of the whole. It forms all the canals whereby the food is carried to every part of the body, the points of the toes, the tips of the fingers, and every nook and corner of the body, thereby sustaining the frame.

In fact, a man 12 stones in weight, if thoroughly dried, would give off about 9 stones of water, and only 3 stones of dried matter would be left. And every day a large proportion of this water is lost from the body, and must be replaced. An average sized man requires to replace from 70 to 100 ounces, or 3½ to 5 pints per day, making during each week from 3 to 4 gallons of water. About one-third of the whole is got from the food he partakes of,—potatoes, beef, &c., and two-thirds, being 2½ to 3½ pints of water, must be supplied in drinking water, tea, or other liquids. Indeed, the best evidence as to the quantity necessary is derived from the Government regulations, which insist that in transport vessels, arrangements must be made that at least six pints, or three-quarters of a gallon of water must be supplied each day to every individual on board in temperate regions, and 8 pints or a gallon each day in tropical regions.

If we add to this the quantity necessary for personal washing purposes, as well as the washing of clothing, houses, &c., the amount runs up to 12 gallons, which may be regarded as the minimum quantity, and, of course, if you use baths, you must add some more to that, and so every person in the community ought to have about 25 gallons per day to keep up proper sanitary measures.

Where water can be readily obtained, we are not to regard this quantity as too much, having reference to cleanliness, and keeping our houses perfectly cleansed; in fact, to fulfil all sanitary requirements. In sickness even more is required, and for trade purposes in large communities a certain proportion still further. In ancient Rome they supplied an enormous quantity—a quantity that puts to shame all our modern notions regarding the supply of water to towns. They had a perfect stream of water carried by aqueducts into the city, 300 gallons being supplied per head per day

In country districts we are content with a great deal less than the proportions I have mentioned, but we must remember that the washing there is often done by the side of burns. In towns such as Edinburgh, people have little trouble with the water. It is brought to their houses, to the stairheads, or to the close end; and the authorities are bound to see to the quality being good. In fact, towns are very fortunate in this respect, for water brought in by pipes from pure country districts is mixed with country air, and if we use the water aright and do not spoil it in its use, we may have it in all its country purity.

Now, what are the sources of water which are introduced into our towns? Of course we sometimes say that the water is obtained from streams or burns or springs, but where do these obtain the water they supply to us? In dry weather they fall in volume, and in wet weather they increase in volume. Apparently there is something external to themselves, and ultimately you find that the rain and snow become feeders of our streams, burns, and springs, and keep up our water supply, or tho rain and the snow may sink a little and escape by drains, or sink still deeper into the ground and appear in the form of springs; but rain itself, and sometimes snow, are the sources of the water we obtain.

In speaking of the use and abuse of water, I should like to say something of its chemistry first. It is a substance which is clear and transparent—at least ought to be so—and which the chemist can now rend practically into two gases. I can take, for instance, some of the water here, and place it in this large vessel, and add to that a portion of the metal potassium which will act upon the water, and we shall find that the potassium seems to run about the surface of the water and take fire. What I have done is not so simple as it appears to sight. The action has been to rend from the water a certain amount of one of the gases in water called hydrogen, and it is this gas which takes fire and burns.

Again, taking the water and putting it into two glasses, I introduce zinc into the one vessel, and then put some iron filings into the second vessel. There does not seem to be any change, but if I now add a little sulphuric acid to these vessels effervescence at once takes place. Cover the vessels up and we shall collect a quantity of the gas coming away from the water. Bring a light near the vessels and the gas takes fire. This combustible gas is the hydrogen, which is merely part of the water, and which readily burns. In fact, we are rending away one of the ingredients of water, and that ingredient is one of the components which the chemist finds in water.

I should like to show some of the other properties of this gas hydrogen. I take this jar full of hydrogen, and then set fire to it, when you will find it burns very quietly and quickly, so that we have in water, as one of its components, a substance which enters into a state of active combustion. Luckily for us the water itself does not enter into such a state of combustion, but nevertheless it contains such a gas. I will show you another point connected with it. The hydrogen itself does not burn. If I take this vessel, containing the hydrogen, and set fire to the contents, and bring the mouth of the vessel down to the table the gas goes out, because it requires air to burn it, as we require air to breathe; and it is only when you let plenty of air get into it that the substance burns itself out, so that hydrogen is a combustible substance, and extremely inflammable when in contact with air, as we have shown by these experiments.

Then, again, hydrogen is a very light gas. I take here two jars containing the gas, and arrange to have one of them with the mouth upwards. I remove the cover from it, and so let the gas escape to the roof. The other I keep with the mouth downwards; the gas cannot get out, because it cannot escape upwards, and it cannot creep downwards through the heavy air surrounding the bottom of the jar. I apply a light to the first jar, and you see there is no combustible gas left in it, because the gas is all away. I take the other jar, which has remained with the open mouth downwards, and set fire to the contents, and you will find that the whole of the gas is there.

Again, here is a little pail at present full of ordinary air, which, when I bring over this light, does not burn, because there is no combustible gas in it. I put the pail into this jar, with the mouth downwards, and which is full of hydrogen, and after taking the pail out, I bring a light in contact with it, and the gas now in the pail burns readily. I take out another quantity and it burns again, and so on. Another way of showing the extreme lightness of this hydrogen is by means of this balloon, which I fill with the gas and then let it rise into the air.

You would fancy that as there are two elements in water they would be very like each other so that they might agree pretty well when united in water, but the chemist finds that such is not so, and if he separates the chemical compound water into its ingredients, that one of them is combustible and the other is not. I have in this vessel a quantity of the other gas that is present in water. It is equally a gas, and we give it the name of oxygen. Its principal property is that it does not burn itself, but enables other substances to burn in it with extreme vividness. I take this piece of phosphorus and set fire to it. I place the jar containing the oxygen over the phosphorus, the effect being that it burns much more vividly. Every kind of water has always the same proportion of these two substances.

We have also in water a certain amount of what is called saline matter. A perfectly pure water would not be palatable. We would not care about drinking it, and it would not be so useful for cooking purposes as water containing saline substances. This saline substance is gathered in this way. The water falls on the ground, passes through the earth and rocks, and takes up a certain proportion of lime and salt, and so becomes more palatable and more healthy than if it were simply a mixture of the two gases I have mentioned. These saline substances I have mentioned are not deleterious, but are highly necessary for dietetic purposes.

Add a very little common salt, as I do here, to this water, and you will find that it gets dissolved, and that it does not give any different appearance to the water, while it is so small in amount that you could not even recognise the salt in the water by taste, but still it is present there. All the water we drink contains a certain proportion of common salt, and chemists recognise it by adding a solution of nitrate of silver, as I do here, which gives the water a milky appearance, which is presumptive evidence that there is a little common salt dissolved in the water. But in order to be quite certain about its being of the nature of common salt, I add some ammonia or hartshorn, and the milky appearance instantly goes away. That indicates to chemists the presence of the common salt, and the proportion of the milkiness produced by the silver salt is suggestive of the amount of the common salt.

Again, if you take and add to some water a little lime, the water gets more or less hard. Add to that water some oxalic acid with ammonia, and you get this white substance you see in the vessel, and thus the presence of lime is detected, and to make more sure you add some hydrochloric acid, and you find that the white colour disappears entirely; so that in these different ways we have evidence of what water is when it is supplied to the town and is brought into our houses, and when we may consider it good water.

Now, water contains air mixed up in it, and as supplied to us from our pipes it has that pure mountain air—the pure country atmosphere—dissolved in it, and this adds to its palatability or taste and wholesomeness. We ought to keep the water as pure in our houses as when we get it from country districts, but unfortunately we often abuse it. Sometimes this is done in cisterns, which are never cleaned out at all, unless when some repair requires to be made. Sometimes, not so much in cisterns as in pails or other vessels in which water is retained, and which vessels are used for other purposes. Sometimes, water is deteriorated in jugs, pots, or pans which are not properly cleaned out, and all these affect the healthiness of the water, and render it more or less unwholesome.

Cisterns are not attended to as they should be. You will sometimes find them shut up in garrets, and in still more inaccessible places, where the woodwork is so thoroughly nailed up that no man can get in at them without breaking the place open. In Edinburgh and elsewhere I am quite confident that much sickness must accrue from the use of water lying in cisterns which are never cleaned out. I show you here a sample of water taken from one of the cisterns in Edinburgh to-day (producing a large glass jar containing water of a dirty brownish colour, with a quantity of sediment in it). Of course the water in the upper part of your cisterns may be quite transparent, but when you get down to one or two inches from the bottom you find a dirty-looking substance. Stir up this, and you will find the same substance as you see here.

I ask you, is it possible that water can be in a state of purity if it stands in our houses in such a state? Is it common sense that you should buy clean bread or beef, store both of them in a clean place, and yet afterwards use these with such water? Is it common sense that you should store up water in your cisterns, into which cobwebs and street dust, insects and other animals find their way, and in which I have known the dead body of a mouse or rat to be found? Is it common sense that you should buy clean food and then cook it with water which has even stood for a single night over such deposits in your cisterns? That is one way in which people abuse water introduced into their houses in purity.

There is always more or less danger in the use of water if the cistern is neglected. If a man does not take much water from the cistern he allows it to flow out without great velocity, and this may not disturb the sediment. If, however, any one in the house wishes a bath in the morning, and draws off much water, there is immediately a rush in of pure water with great velocity, so that the sediment in the cistern gets disturbed, and the next operation is probably that water is drawn off for cooking purposes, bringing along with it more or less of this sediment. In the cleaning out of cisterns great care must be taken. I remember a case of a lady who instructed her coachman to clean out the cistern of the house. He, wishing to make a good job of it, got a bath-brick and a hard scrubbing brush, and got into the cistern, tackety boots and all, and brushed away till he could almost see his face reflected from the lead. The water which was then introduced came in contact with the bright lead, and immediately began to dissolve away the metal, and acquired poisonous properties. Lead should always retain its natural skin—the tarnished look, and if you wish to clean out your cistern properly, use the softest hearth-brush you can get. Let the water flow away, and move about this soft brush so as to stir up the sediment; then lift the waste-pipe and let the whole of the remaining water go.

I want you clearly to observe the enormous power which water has of absorbing gases, and to give you some notion that whenever gases come in contact with water, they are liable to become absorbed by it. I have got an arrangement to show this. Here is some ordinary water, to which I add, in the first instance, a little colouring matter, so that we may see it in any vessel into which it may rise. I then take this large flask, which has a narrow glass tube inserted in it, to the top. We are going to fill this flask with a considerable quantity of gas, and for that purpose I will connect the tube which enters the flask with a second flask, in which I place a small quantity of ammonia, which I can drive off in vapour by applying heat to the second flask. There is a long flexible tube that terminates in the narrow tube of the first flask into which I am going to drive the ammonia vapour. I wish by this experiment to show you how water absorbs gases, as I believe much injury arises not only from the deposits in water, but likewise from the water having gases absorbed in it, through the cisterns being in such positions as necessitates gases being absorbed by the water. I know by the odour of hartshorn that we have got sufficient in the flask, and I place the mouth of the flask in the jar containing the coloured water, which you see now rises into the flask, quite absorbing the gas, so that the water is actually sucked into the flask.

Water, therefore, has the power of absorbing gases which may be given off from deposits in the cisterns, or otherwise near the cisterns; in such circumstances, therefore, we should be careful about our cisterns, and remove those ugly deposits which are liable to be present. We should also put the cisterns in such positions in our houses that pure air could flow over the water, rather than allow stagnant and foul air to come in contact with the water, of which I am sorry to say there is too much.

Water is also liable to be contaminated when put into pails which are not properly cleansed. We can only hope in many of the smaller houses to have the water supplied in pails, but I am afraid, from practices which go on occasionally, it is a very common thing for washing-water and slops to be taken out in the pails, after which they get a little rinse out, and then pure water is poured into the same pails, and taken into the house. Now, that is a great source of the contamination of water. Water taken from such a pail would not now-a-days be passed for dietetic purposes as pure water by any chemist in the country. I take here two vessels which are clean just now. I put into this one a material which may be called to some extent polluted, and I roll it round the side of the vessel, and then pour it out, and I fill up the two jars with portions of the same water. There is an easy sort of way to test such water, and that is by using a coloured substance, Condy's fluid, which I have here, though that is not always a safe guide. I pour half of the coloured liquid into this vessel, where we have no reason to believe there is any impurity, and you will find there is a nice pink colour distributed throughout the vessel. But if I take the other half of the coloured liquid, and add it to the contaminated water in the dirty vessel, the pink colour disappears, owing to the impurity in the water. We can thus demonstrate that water can become impure in these pails, and prove the necessity for thoroughly cleansing out all vessels intended for conveying or retaining water.

The gases we previously spoke of may be accompanied by certain germs which are hurtful to us, and which, though invisible to us, may still be floating about in the atmosphere and water. I have got here a bottle which contains a little chlorine, and which is a very powerful agent in our work. I have also some turpentine, which is perfectly clear and transparent, and I take a piece of thin paper, which I intend as a means to introduce the vapour of the turpentine into the bottle. I pass the paper through the turpentine, and you see that though it becomes wetted there is no essential change in its appearance. In the atmosphere surrounding the paper, there is now the vapour of turpentine, though such is invisible, and such turpentine, like the noxious germs in polluted air and water, contains carbon particles. I put the paper with the turpentine into the bottle of chlorine, and separate the carbon. You find there is a disengagement of vapours, and the side of the bottle becomes coated black with the carbon.

I would advise that no pail or vessel should be employed for pure water that is used for slop water at all. Nothing is better for the conveyance of pure water than a good tin can or pail with a cover on it. Never use a galvanised iron pail, which is apt to give a zinc taste to the water, and render it nauseous and more or less unwholesome. In regard to jugs, pots, pans, and dishes, these, of course, should be washed immediately after each meal, for if they are not it is difficult to remove the organic matter attached to them.

In the use of water for cooking, there is a practice in many houses of using reboiled water, which has been boiled, simmered, and then boiled again in a kettle or pot, and after that the meal is cooked with it. If, however, fresh water were introduced each time, it would make the food more palatable. The water ought to be put into the vessel cold, and when it comes to the boil, be instantly employed for dietetic purposes. I instance tea especially, which would be better tasted by following this advice, and the extra two or three minutes required for the operation would be very well spent indeed.

I have referred to water standing in our cisterns, and I have to tell you now never to use stagnant water whether in cisterns or in pails. After cisterns have not been used for two or three days, run the whole of the water off, and introduce fresh water. As to filters, after being used for two or three weeks, they get worse than useless. They retain the impurities which get lodged in them; and warmed by the temperature of the room in which they may be situated, they contaminate the water more than if you had never used the filters at all. Filters, too, on the large scale, after being in use, become infected with organic matters, and should be cleansed; such matters, certainly, do not conduce to the healthiness of the water.

In country districts they are much worse off than we are in towns for water supply. Wells, and sometimes ditches, are resorted to, and in getting rid of the slops the readiest and easiest is generally the method adopted—that of throwing them out on the road in front of the houses. And now let us see what is done in regard to houses in country places. A man often goes and builds a house in the country, in a spot selected without reference to water supply; and after he has put up his house, then he begins to think about water. In many cases he finds that the easiest and cheapest way is to dig a hole near the house, which he calls the well. The water is introduced into his house, and he uses it for all purposes. He must, however, get rid of the dirty water, and he digs another hole to receive it. He leads a pipe from his house, and runs all the impure waters into that second hole, which he calls his cesspool. The well must have water, and as the cesspool begins to get filled up with water containing some not very nice things, the liquid contents find their way through the earth towards the well, and the water becomes impregnated with organic matters. The result is that in a very short time—it may be after having been in the house for a few months—illness breaks out in the family, and the householder cannot understand what has caused the illness in the family. Again, another man may build a house close by the ground where the first cesspool is situated, and of which he knows nothing. He also wants to get a supply of water, and digs a well which may be close by his neighbour's cesspool, probably within three feet of it. The matter from the cesspool of the first party finds its way into the water contained in the well of the second, who also begins to wonder why he should not enjoy the best of health. Again, a whole row of small houses may be built, and a well be put down beside them. All the dirty water may be thrown out into a gutter near the well, and the result is the contamination of the water.

In these observations which I have made, I have endeavoured to give you some notion as to the manner in which we ought to use water, and as to the manner in which I am sorry to say we abuse it. One word as to impure water and its effect upon health. There can be no doubt of cases where contaminated or impure water has led to ill health, and where noxious germs are introduced into the system by means of liquids such as water and milk, through which they are at once carried into the system. Nowadays it can hardly be a question whether impure water engenders disease, and there can be no question whatever that bad water influences the healthy state of the animal frame, predisposes individuals to attacks of illness, and thus aids and abets the propagation of disease. Its action is markedly observed in cases of diarrhœa, cholera, and typhoid fever. I have had a good deal to do with the shutting up of wells in districts where such illnesses prevailed, especially over the Fife district during 1866. It was wonderful how these polluted wells became the means of promoting that dreadful disease cholera, and medical and sanitary officers recognised this fact. One wrote me saying: "It is a remarkable fact that the deaths from cholera were chiefly, if not altogether, in the vicinity of these wells." Another wrote: "On learning the result of your analysis the well was shut up, and the attacks then ceased." I need hardly say, because it is a matter which has occupied much public attention lately, that typhoid fever is also spread by such impure waters. The use of such water also lowers the tone of the system, and renders the man or woman less fit for work.

An abundant use of water ought to be encouraged. The deficient use of it means personal cleanliness not attended to, clothes not properly washed, rooms not thoroughly cleaned out, and cooking not the most cleanly. To talk of the waste or the abuse of water in its liberal use, or to stint its use in any way in our houses, is false sanitary doctrine and practice. I would like to see a more liberal use of water in Edinburgh for private and public purposes. Why should we not have public wash-houses, under municipal control, in various parts of the city where, for a few pence, there could be secured hot and cold water, washing tubs, and drying arrangements for the most homely of washings? Why should we not have public baths under municipal control, distributed here and there over the town, where on Sundays or week days, for a copper or two, any man or woman, boy or girl, could thoroughly cleanse themselves? Other towns and cities have such advantages in abundance, and Edinburgh, with its large supply of fresh water and a near supply—which could be readily obtained—of salt water, should not be behind other places. And more, why should we not have flushing stations in connection with all our main drains, where a large body of water could be regularly sent down our sewers to flush out all impurities, and in conjunction with open street grating-ventilators, purify the sewers?

Sanitary science demands that water should be supplied and be used in populous places without stint. We ought, therefore, to encourage its use instead of discourage such. Air and water are public property, and any proposal to restrict their use is not sound sanitary policy. A disuse of water, or a scanty measure of it, is not only an individual disaster but a public calamity. Pure wholesome water is a mighty blessing, and happy the town which can command plenty of it.

APPENDIX.

THE USE AND ABUSE OF WATER IN HOUSES.

THE WATER SUPPLY OF A HOUSE is one of the principal factors which regulate the health of the people residing within the house.

In importance it stands side by side with the air supply. Both minister directly to the sanitary condition of our homes; and on the use or abuse of air and water depend much the rate of sickness and even the rate of death in every family, especially in the younger children, who are much influenced by such agencies.

The Water Supply of a house is not only useful for washing and cooking purposes, but it is *food* itself. The bodily frame consists of water to the extent of three-fourths of its entire weight; and water forms all the canals whereby the ordinary food is carried to all parts of the body.

About 70 to 100 ounces, or 3½ to 5 pints, of water are required every day to replenish the loss of water from the body of every man and woman, one-third of which is obtained in the bread, potatoes, beef, &c., and the remainder, being 50 to 70 ounces, or 2½ to 3½ pints, must be taken as drinking water, tea, &c.

Washing of the person, with an occasional bath, washing of clothes, washing of dishes, and washing of rooms and furniture, require much extra water, so that where the water can be easily got at about 25 gallons should be used for each person during each day.

Towns, such as Edinburgh, are fortunate in having the water brought in from country districts, mixed with country air, and led into our houses, or at the stair head, or at the close foot, and if we use the water aright we can drink it with all its country purity.

IN THE USE OF WATER IN HOUSES we should endeavour to keep it as pure as we get it, but, unfortunately, we often abuse it, foul it, or dirty it, within our own reach.

Sometimes cisterns are never cleaned out.

Sometimes water pails or other vessels are used for other and less cleanly purposes.

Sometimes jugs, pots and pans, and dishes, are not properly cleaned.

THE CISTERNS are liable to have deposits settling in them, consisting of earthy matter, street dust, insects, an occasional rat or mouse, etc., which give off noxious matters to the water; and from the position of the cisterns in many houses, noxious gases are also liable to be absorbed by the water.

PAILS, STOUPS, AND CANS, used for bringing in water into houses, are often used for washing purposes, or for taking out slops.

If the house has a cistern, see that it is occasionally cleaned out with a soft brush, lift the waste pipe, and let the dirty sediment escape. If the water is taken into the house in a pail or other vessel, never use such for any other purpose. The best and most cleanly vessel to use, is a tin can or pail with a tin cover. Do not put clean water in a galvanised iron pail.

If you go to the country for work or otherwise, be careful where you get the water. Many well waters are polluted and unwholesome. See that no slops are thrown out near the well, or dung-heaps or ash-pits situated there. Running water is often more healthy than well water.

IMPURE WATER leads to ill health. Noxious germs are liable to be carried into the system, and if not directly causing disease, at least predispose people to attacks of disease, such as diarrhœa, cholera, and typhoid fever, and even where no serious disease breaks out, the impure water lowers the tone of the system and renders the man or woman less fit for work.

Use water abundantly. A deficient use of water means

Personal cleanliness not attended to.
Clothes not properly washed.
Rooms not thoroughly scrubbed out; and
Cooking and dishes not the most cleanly.

THE ABUSE OF WATER does not lie in the large or liberal use of it, but in rendering what we do use uncleanly, and unfit for healthy use.

Always keep the sink and closets—whether in the house or on the stair head—very clean, and use plenty of water for the purpose. Do not stint the use of water for flushing sink and closet pipes. A good rush of water will carry away obstructions and keep things sweet.

THE USE AND ABUSE OF ALCOHOLIC STIMULANTS AND TOBACCO.

BY PROFESSOR THOMAS R. FRASER.

ON the Evening of Saturday, 29th January, Professor Fraser delivered the ninth of the Course of Health Lectures in the Free Assembly Hall, his subject being "On the Use and Abuse of Stimulants and Tobacco." Professor Fraser said :—

LADIES AND GENTLEMEN,

We have all heard of the young man who has no vices. He has been held up before the youth of this country—and probably of many other countries—as a model to be imitated ; but, unfortunately, the model has not been adopted so generally as to give complete satisfaction to fond wishes and affectionate interest.

We who are familiar with this model, are aware that the vices from which he is free are chiefly those which are included in the subject of my lecture this evening. I shall have much to say of the vicious results that follow the *abuse* of stimulants and tobacco ; but you will observe, the title of my lecture imposes upon me the duty also of considering their *use*.

This title is not one for which I am responsible, but I am not sorry that it has been selected.

The subject of the use and abuse of stimulants and tobacco has for some years largely engaged attention. It has been considered by medical men, by physiologists, by politicians, and by social reformers, and the greatest benefit has already resulted from this consideration. I cannot avoid thinking, however, that the benefit might have been even greater than it is, had social reformers—

with the best of intentions—exercised a little more caution in the statements and arguments by which they have endeavoured to advance their opinions. Enthusiastic for the good of their fellow-men, they have at times been led by their enthusiasm to ignore what has not been proved to be bad, and to exaggerate what is assuredly bad. They have neglected the *use*, and perhaps exaggerated the *abuse* of stimulants and tobacco; and by so doing it is to be feared they may have impeded the progress of the reforms they so ardently desire. Had they submitted to the wise dictation of a public-spirited committee, such as that which has so admirably arranged this course of lectures—and in whose praise I can speak with all the more freedom because I do not even know their names—some of these errors would have been avoided by the restraints and guidance of an imposed title.

There are few things of the nature of luxuries which are so largely consumed as stimulants and tobacco. Understanding by stimulants, alcoholic beverages, it is not too much to say that the consumption in this country is represented by millions of ounces of alcohol, while that of tobacco is represented by millions of pounds; and I need not remind you that this country has no monopoly in the consumption. Alcohol, in some form or other, is used as a drink by the majority of the inhabitants of nearly every country, and there is no nation in the world to whom the use of tobacco is unfamiliar. The prevalence of this consumption over the whole world, and among individuals of every class, of every occupation, and of every degree of moral and mental condition, is in itself a strong reason for avoiding indiscriminate or intemperate attacks. It is useless to attribute this extensive use to mere imitation or inherent vice. Some effects must follow which are pleasing or beneficial; and if the evils of abuse are to be rationally met, these effects should not be ignored, but should be dispassionately considered along with those that are productive of mischief. Now, ladies and gentlemen, I think it will be most convenient if, in what I am about to say, I first of all speak of the effects of stimulants, and then of tobacco.

STIMULANTS.—By "stimulants" I think we all mean beverages that are capable of producing in large quantities intoxicating effects. I do not think, when we use this word, we generally mean such substances as tea and coffee, though they also may be correctly spoken of under the same designation. The stimulants I wish to say a few words about to-night, are such beverages as whisky, wine, and beer, all of which owe their leading properties to a liquid contained in them called alcohol, which you may know in its nearly pure form of "spirits of wine." For this reason, they are spoken of as alcoholic stimulants. In whisky, wine, and beer, the alcohol is mixed with water, and, accordingly, the alcoholic strength of these beverages varies considerably, as you will see from the table :—

TABLE I.—Percentage by volume of absolute Alcohol in several common Alcoholic Beverages, with the quantity of the Beverage representing about one ounce of absolute Alcohol.

BEVERAGE.	Percentage of absolute Alcohol.	Average percentage of absolute Alcohol.	Quantity representing about one ounce of absolute Alcohol.
Spirits—			
Brandy . . .	50 to 60	50	2 ounces, or 1 small wine glass.
Whisky . .	50 ,, 60		
Gin . . .	49 ,, 60		
Rum . .	60 ,, 77		
Strong Wines—			
Sherry . . .	16 ,, 25	20	5 ounces, or 2 wine glasses.
Port . . .	16 ,, 23		
Madeira . . .	16 ,, 22		
Marsala . . .	15 ,, 25		
Light Wines—			
Bordeaux (Clarets) .	6·8 ,, 13	10	10 ounces, or 4 wine glasses.
Rhone . . .	8·7 ,, 13·7		
Champagne . .	5·8 ,, 13		
Malt Liquors—			
Beer . . .	1.2 ,, 10	5	20 ounces, or 2 tumblers.
Ale . . .			
Stout . . .			
Porter . . .			

They may also contain sugar, acids, and other substances which produce some differences in their effects. Their chief effects, however, depend on the alcohol they contain, and for the sake of simplicity, therefore, we may ignore the other substances, and consider only the effects of the alcohol.

Let us consider these effects; but before doing so in detail, I should first point out that they vary greatly according to the quantity that is taken. This is so obvious, I need scarcely dwell upon it. We know that with everything that produces effects the quantity that is taken modifies the degree and apparently even the kind of the effects. A small pinch of salt is a pleasant and almost indispensable addition to the meat or potatoes we eat; but one or two tablespoonfuls of it produce very quickly sickness and vomiting. A very little whisky and water makes one feel warm, and perhaps a little light in the head; a wine glassful of whisky will make many people intoxicated and unable to walk steadily or speak distinctly; and a tumblerful will soon render them insensible, and probably act so decidedly as a poison that it will quickly produce death.

In speaking, therefore, of the effects of alcoholic stimulants, we must bear in mind the differences in the effects that are due merely to the differences in the quantity taken.

First let me speak of the effects or action upon the stomach and digestion. When a small quantity is taken, the juices which are poured out from the stomach walls, and which are necessary for the digestion of food, are increased, and the food is more rapidly and thoroughly digested. This occurs only if the small quantity is mixed with much water—is well diluted, in short—and unless it be well diluted, digestion is not made more rapid, but it is impeded and less perfectly performed than it should be. Heartburn, pain, and other signs of dyspepsia follow, and they become uncomfortable and only too familiar monitors, whose hints are, however, very frequently neglected by those who habitually partake of undiluted or insufficiently diluted spirits when there is little or no food in the stomach. If the insufficiently diluted spirit, or even if sufficiently diluted spirit be often taken, then the structure of the stomach becomes changed. It becomes inflamed and thickened, and incapable of producing a large enough quantity, or a proper quality, of gastric juice to digest food; and from this it follows that dyspepsia of a lasting or chronic kind is caused.

When the alcohol is introduced into the stomach, however, it does not remain there. Part of it at once passes into the blood-vessels in the walls of the stomach, and is in that way carried through the whole body. Many other parts of the body besides the stomach are consequently affected by it. Even a small dram, for instance, makes the face, neck, and hands redder than they previously were; showing that the state of the circulation has been modified. If we examine the circulation a little more, we will find that the pulse at the wrist beats faster, and becomes larger and more full, and that the strokes of the heart are stronger. When these changes take place, we know that the blood is flowing more quickly and in larger amount; and that this implies an increase in the supply of blood to the different organs of the body. Such an increased supply is very likely to be followed by an increase in the activity of the organs receiving the blood, for their activity depends partly upon the quantity of blood they receive. I wish to direct your attention particularly to this action of alcohol, for it is the action which has led chiefly to the reputation alcohol has gained as a *stimulant;* as a substance which stimulates or excites, for example, the appetite, or the digestion, or the brain, and which makes it remove the general state of the body which we speak of as fatigue. Now, I think there can be no doubt that it does all this; but you are not to think that it is the only substance which can do it, and much less are you to think that it can be used for this stimulating purpose without risk. The conditions in which it may be employed are those in which the parts of the body I have referred to are in an abnormal or not perfectly healthy state, and accordingly it should be used as a stimulant only in those states. In a healthy state, the stimulating action results in the production of injurious rather than of beneficial changes, even if only a moderate quantity be taken, and much more if a large quantity be taken ; or if any quantity able to produce distinct stimulation be frequently taken. If, indeed, a large quantity be taken, stimulation is not observed, but an opposite effect. The large quantity undoubtedly acts as a poison, quite as distinctly as arsenic or prussic acid : and in books on poison, instances are recorded in which death has followed a short time after the drinking of large quantities of alcohol in the form, for example, of whisky.

The stimulating effect upon the circulation is, in other respects also, of an undesirable description, and it is not generally productive of real benefit to the individual. For example, it has led to the notion that alcohol is able to make one warm, that it is a substance that raises the temperature of the body. This notion is very much due to the sensation of heat, to the glow which results from the blood-vessels of the skin becoming dilated. It prompts the street porter to make frequent visits to the convenient public house during cold weather, and the driver of the stage coach to take a "glass" at each inn before whose door his coach draws up. But it is entirely erroneous for them to suppose that each glass of whisky actually increases the temperature of their bodies. The dilated blood-vessels which suggest to them that alcohol is a warming substance, in reality cause a reduction of temperature, by permitting a rapid cooling of the blood when the surface is exposed to cold; and therefore the street porter soon fancies that another glass of whisky would do him good, and the coachman is only too impatient to see the sign-post of the next inn. The dilated vessels also permit of a *sudden* cooling of the blood to take place ; and so it is that diseases of the kidneys, of the liver, and of the brain, which are of frequent occurrence in those exposed to vicissitudes of climate, are not altogether to be explained by climatic influences.

This dangerous or bad effect of alcoholic stimulants has, I have little doubt, been productive of much injury during the Arctic winter, which I trust has now left us. We know that it actually does so in the Arctic regions. Travellers have found that in any shape they are not only completely useless, but positively injurious. They stimulate for a short time, and make one feel warm for a short time, but exhaustion occurs more quickly, and the cold becomes more difficult to bear when they are used. The last Arctic Expedition from this country—that of Sir George Nares—was not so successful, you may remember, as everyone wished; and the committee which enquired into the causes of its failure had a great deal of evidence brought before it by the officers and sailors who took part in the expedition, and also by many former Arctic travellers, as to the value of stimulants and different foods in cold climates. I see that Admiral Inglefield—with whom I served as a member of the committee—has written a letter which appears in to-day's *Scotsman*, in which the result of that evidence is very fairly stated. It was that to take alcoholic stimulants to keep out cold is a fallacy, and that nothing was more useful for that purpose than a good fatty diet, with hot tea or coffee, and not spirits, as a drink.

This was also the experience of the leaders of Napoleon's campaign into Russia, and the monks of St Bernard find that death from cold is hastened by alcoholic drinks.

Let us now consider if the nutrition of the body is in any obvious manner affected by alcohol. It is every day observed that many drinkers of alcohol grow stout, and even uncomfortably fat. The explanation of this is to be found in the fact that alcohol lessens the waste of substances in the body, whether these be of the nature of food or of formed tissues, and also somewhat facilitates the absorption of the fatty portions of the food from the stomach. We accordingly see why those who drink alcohol even moderately, especially if at the same time they consume food rich in fat (or what leads to the same result, in sugar or starch), are apt to become stout from a deposit of fat taking place under the skin; and why those who take alcoholic stimulants immoderately are, in addition, very likely to have fat deposited in some of the organs of the body, where its presence constitutes the disease, fatty degeneration.

We are, also, able to understand why stimulants, which not only stimulate, but also lessen the changes in the constituents of the body and of food, are for this reason specially injurious to young persons. The forming of the tissues and structures of which the body is composed requires that the constituents of these tissues, and the foods from which they are made, should be allowed actively to rearrange themselves into appropriate forms and compounds, and everything which interferes with these rearrangements retards growth and nutrition. As growth and nutrition should be allowed to proceed unchecked in persons whose bodies are growing, alcoholic beverages must act most injuriously on young persons, and, apart from every other reason, their frequent use, and much more their use as daily articles of consumption by children who are not suffering from illnesses which may require them to be given medicinally, is undoubtedly prejudicial to their physical development.

It is, however, commonly asserted that alcoholic stimulants are *foods.* A great deal of trouble has been taken to find out if this is the case or not. I think some of the most satisfactory, because eminently practical, observations that exist to assist us in deciding this very important question have been made by a distinguished physiologist and physician of America, Dr Hammond. He tested the food value of alcohol upon himself in this way: During a few days he lived on a diet that was *sufficient* to maintain the body at the usual weight and in a healthy condition; during a second equal number of days he lived on a diet that was *insufficient* to maintain the body at the usual weight, for while living upon this diet weight was lost; and during a third equal number of days he lived on a diet that was *more than sufficient* to maintain the body at the usual weight. During each of these three series of days he daily took the same, and only a moderate, quantity of alcohol in the form of wine. He found that the addition of alcohol had the effect of increasing the weight of the body, whether the food was sufficient, insufficient, or more than sufficient in amount—a result which you are not unprepared to learn from what I have already told you of the effect of alcoholic stimulants upon nutrition. He found, however, more than this; for while the alcohol seemed to supplement the deficiency of food when an *insufficient* diet was taken, it produced disturbances in health when the food was either sufficient or excessive in amount, such disturbances, for example, as palpitation, rapid pulse, dyspepsia, laziness, and indisposition for mental or physical exertion —the disturbance of health being greatest during the days in which an excessive amount of food was taken.

There is one lesson, at any rate, which these experiments most emphatically teach, and that is that alcoholic stimulants are altogether unnecessary as foods when a sufficient quantity of ordinary food is being taken.

When the food is sufficient, or more than sufficient, they produce disturbances in health, some of which I have told you of. They were produced within the very few days during which Dr Hammond's experiments were continued. But in the numerous experiments, for objects totally unconnected with science, which are being made on all sides and by all classes, the use of the alcoholic stimulants is not restricted to a few days or even weeks, and the effects produced are not the mere temporary ones that I have mentioned. These temporary effects are to be explained by the alcohol acting directly upon the stomach, and then, after it is absorbed into the blood, acting upon the heart and blood-vessels, the brain, liver, and many other important organs. If such consequences can follow an action restricted to a few days, it would be foolish to suppose that more serious and more permanent effects will not follow an action extending over months and even years. It would also be contrary to the facts daily brought under notice to make this statement. We physicians have unfortunately only too good reason to know that the stomach becomes unable properly to digest food, that the brain become enfeebled, that the liver and kidneys become unable to perform their necessary functions, and that the heart and blood-vessels become unfitted to circulate the blood, as a result of disease in the structure of each of these organs, directly caused by the habitual use of alcoholic stimulants in excessive quantities, and even in quantities which many persons would not regard as excessive.

One of the series of experiments I have referred to indicates that alcohol may act as a food. Its applications as a food are very limited. It may supplement an insufficient dietary, where insufficiency is an unavoidable condition; and illustrations of this use of it are to be found in the records of sieges, as in that of Paris during the last Franco-German War. It is to be recollected that it is an expensive food, and also that, while it acts as a food, it at the same time lessens the activity of nutrition, upon which the production of force depends. Men undergoing great and prolonged physical exertion work as well, if not better, without alcohol as they do with it. The experience of recent campaigns which have been successfully conducted on total abstinence principles, have proved that men *in a healthy condition, and supplied with a sufficient amount of food,* retain their health and are capable of performing the most arduous labour, in every variety of climate, without alcohol. And further, in some of these campaigns, opportunities were afforded for observing that the addition of alcohol to the diet may actually diminish the capability for prolonged physical exertion.

When we direct our attention to mental work, I believe the same conclusion must be arrived at. The stimulating action on the brain of quantities far short of intoxicating, is accompanied with a paralysing action which seems most rapidly and powerfully to involve the higher faculties. Mental work may seem to be rendered more easy, but ease is gained at the expense of quality. The editor of a newspaper will tell you that, if he has been dining out, he cannot with confidence write a leading article until he has allowed sufficient time to elapse for the effect of the wine he has drunk, in moderation, to pass away; and even the novelist, whose brainwork is in the regions of imagination, will relate a similar experience.

Now, ladies and gentlemen, I have to some extent illustrated the results that follow the use of alcohol and the injurious consequences that follow its abuse. The latter, as we have seen, include the production of several diseases; and as you might expect, these diseases have an effect upon the duration of life. Let me now direct your attention to some tables in which this effect is plainly shown:—

TABLE II.—Ratio per cent. from the undermentioned Causes to Deaths from all Causes.

Cause of Death.	1847.	Gotha Life Office.	Scottish Widows' Fund.	Intemperate Lives.
Head diseases, . . .	9·710	15·176	20·720	27·10
Digestive organs (especially the liver), . . .	6·240	8·377	11·994	23·3
Respiratory organs, . .	33·150	27·843	23·676	22·98
Total of above three classes, ...	49·100	51·396	56·390	73.38

TABLE III.—Expectation of Life among the Temperate and Intemperate. (Derived from rather limited data.)

A Temperate person's chance of living is—	An Intemperate person's chance of living is—
At 20 = 44·2 years.	At 20 = 15·6 years.
,, 30 = 36·5 ,,	,, 30 = 13·8 ,,
,, 40 = 28·8 ,,	,, 40 = 11·6 ,,
,, 50 = 21·25 ,,	,, 50 = 10·8 ,,
,, 60 = 14·285 ,,	,, 60 = 8·9 ,,

TABLE IV.—Mortality among Intemperate Spirit and Beer Drinkers.

Spirit drinkers, ...	5·996 per cent.	(nearly 60 per 1000).
Beer drinkers, ...	4·597 ,,	(nearly 46 per 1000).
Spirit and beer drinkers, . .	6·194 ,,	(nearly 62 per 1000).

This effect upon the duration is also shown when a comparison is made between the expected and actual claims in the temperance and general sections of insurance companies. In the case of one insurance company, the results of such a comparison have been communicated to me through the kind interest of one of my colleagues, Professor Calderwood. It shows that while the claims in the temperance section are 30·5 per cent. below the expected claims, in the general section they are only 0·7 per cent. below the expected claims.

The statements I have now laid before you are sufficient to show that the use of alcohol is very limited, while its abuse is productive of many injurious consequences. Its employment as a daily beverage cannot be justified on the ground that it increases the capacity for work, that it makes the body warm, or that it acts in ordinary conditions as a food. We are entitled to assert that the chief justification that can be advanced is that it is a luxury. No doubt, to many, the reprehensible pleasure of intoxication, in some of its degrees, is the main inducement that leads to abusive indulgence in it. In that case, it certainly leads to, if it be not a mere evidence of, mental and physical degradation. But, whatever be the inducements to immoderation, we must not conceal from ourselves that it is often originated and strengthened by erroneous notions regarding the effects of alcoholic stimulants, and by the conditions in which many persons exist.

Too often a craving for alcohol is originated and encouraged by insufficient and badly cooked food, and by the overcrowding and the defective ventilation of dwelling-houses.

The removal of the erroneous notions to which I have referred will probably effect much good; and a great reduction in the amount of intemperance may be expected to follow the improvements which are now being carried out in the sanitary condition of our large cities.

TOBACCO.—I pass, with some relief, to the consideration of the second subject on which I have to-night to say a few words, because I do not think it can be proved, whatever assertions may be made, that the moderate use of tobacco is followed by so many evil consequences, nor even that its immoderate use is so likely to lead to such serious diseases of the body and mind as may justly be attached to the abuse, or even to the injudicious use of alcohol.

It may interest you to know that tobacco is made from the leaf of an American plant called *Nicotunum Tabacum;* and that it appears to have been employed for smoking by the natives of South America from time immemorial. Some of its properties were first learned by Europeans, through the enterprise of the famous discover, Columbus. In 1492, when his ships were lying off Cuba, he sent two sailors to explore the island, and on their return, among other wonderful things they reported, was a custom of the natives to puff smoke from their mouths and noses. Other travellers had their curiosity excited by observing this remarkable habit among the natives of different parts of the New World; but tobacco was not introduced to the Old World until nearly a century afterwards. The origination of the custom of smoking in this country is generally attributed to Sir Walter Raleigh, who certainly made it fashionable, and gave it "a good standing in society;" so that in a short time to smoke "with a grace" was looked upon as a necessary accomplishment of a gentleman. Among the uninitiated the custom excited wonder, and sometimes alarm. It is recorded, for example, that on one occasion when Sir Walter Raleigh was taking a "private pipe," a servant entered his room, and seeing the smoke proceeding from his master, concluded that he was on fire, and thereupon threw the contents of a jug of ale over his face to extinguish the conflagration.

The custom of smoking also excited much opposition. Pagan, Mahommedan, and Christian monarchs combined to check its progress. Edicts were promulgated and books written with this object; and one of the latter still survives as a protest against tobacco smoking. This is the "Counterblast to Tobacco" of King James the first of England, in which the following passage occurs:—"Surely smoke becomes a kitchen farre better than a dining chamber; and yet it makes a kitchen often times in the inward parts of men, soyling and infecting with an unctuous and ugly kind of soote as hath been found in some great tobacco takers, that after death were opened. A custom loathsome to the eye, harmfull to the braine, dangerous to the lungs, and in the black stinking fume therof, nearest resembling the horrible Stygian smoke of the pit that is bottomless."

Opposition, however, was of no avail. The custom continued to spread, until it became common among the inhabitants of every known country.

Now, what is the reason of this extension and prevalence? Are they to be accounted for by that spirit of opposition in the human disposition, which is said to induce tenacity of adherence to customs and opinions which are intemperately censured, especially when to intemperate censure is added an exaggerated statement of evil effects, such as characterises the "Counterblast" of King James? Or is the explanation to be found in the fact that the custom itself is not only free from the direful effects that have been attributed to it, but even that it is productive of some effects of a useful description? It is impossible to answer these questions until we have considered the influence that tobacco exerts upon the human body.

Its attractions certainly are not manifest on a first introduction. The first pipe is generally a horror which is not soon forgotten. The novice discovers he has a stomach, he becomes acquainted with the sensations of utter prostration. Even after familiarity with the indulgence, a temporary excess soon conveys an unmistakeable warning of the activity of tobacco. Should this warning be neglected, then we know that life may be endangered, for there are instances of death from smoking. This has occurred in a novice after only two pipes, and in habitual smokers after seventeen or eighteen pipes were continuously smoked.

These disagreeable and dangerous effects cannot certainly constitute the attractions of tobacco smoking. If you ask a smoker why he smokes, I am afraid the answer will generally be an unsatisfactory one. Very often it may be, because a soothing, tranquillizing effect is produced, because mental work or physical exertion is rendered more easy, or because it assists to kill spare time. These or similar reasons, or excuses, are often advanced as a justification of the indulgence, and I do not think you will be prepared to say that, if they are the actual effects of smoking, they do not somewhat justify the habit.

But the answer which the smoker will often give does not embrace all the information that has been acquired. It would be unfair to form an opinion from that answer, and, therefore, I shall next proceed to place before you some other facts regarding the action of tobacco.

I have hitherto spoken of the smoking of tobacco only. You know very well that the indulgence in tobacco includes also the snuffing and chewing of that substance. Snuffing and chewing are not so common habits as smoking, and therefore I will not say anything about them except that both produce the same effects as smoking, although snuffing does so to a much less degree, and chewing to a greater degree than smoking.

When tobacco is smoked, its action is modified by the strength of the tobacco, and by the form in which it is smoked. The strength depends on the quantity of the active substances it contains. These are chiefly an oily substance, which in very small quantity produces sickness and headache; and a liquid, which may be got from the tobacco by distilling it. This liquid, some of you may know, is called nicotine; and it is so strong a poison that it may be likened to prussic acid, and if a small drop of it is given to a dog, the dog will die very quickly. Fortunately, there is only a minute quantity of it in tobacco, as it is impossible to get more than four or five drops from an ounce of strong tobacco. Fortunately, also, when tobacco is burnt, much of the nicotine is also burnt, so that only a minute trace is present in the smoke. A part of it and of the oil, also, adheres to the stem of the pipe, or the end of the cigar; and this explains why it is that a cigar becomes stronger as it is being finished, and why a new clay pipe is much weaker than an old well-seasoned cutty. The "juice" in an old pipe contains a large quantity of both substances, and it is so poisonous that the greatest care should be taken in keeping such pipes from children.

When tobacco is smoked by a person who is not altogether new to the practice, a great many parts of the body are soon affected.

The brain is a little excited, intellectual work is made more easy and less fatiguing, and any tendency to sleepiness that may exist is removed. In a person accustomed to the use of tobacco, intellectual work is difficult when smoking cannot be indulged in, the mind cannot easily be concentrated on a subject, and unrest is produced—but this disappears when recourse is had to smoking; and probably some of its reputation as a soothing agent has on this account been acquired.

The circulation is also a little excited, and no doubt this assists in rendering brain work more easy. In a short time, however, the circulation is slightly depressed, the pulse becoming smaller; and this may assist in producing the soothing effect generally experienced.

The digestion of food and the nutrition of the body seems also to be affected. Moderate smokers not uncommonly smoke a short time after dinner, the principal meal of the day. The reason for this may be found in the fact that several of the fluids, or secretions—of great value in the digesting of food—are increased by tobacco. The nutrition of the body also is modified by tobacco. A series of experiments similar to those I have spoken of in connection with alcohol have been made by Dr Hammond with tobacco, and they showed that when the food is sufficient in amount, tobacco increases the weight of the body; and when the food is not sufficient, and the body in consequence would lose weight, tobacco restrains the loss.

Now, ladies and gentlemen, I think that in many of these actions, or in the aggregate of them, we can discover the reasons that have led to the prevalence of tobacco smoking, and which have caused smokers to persevere in the habit, notwithstanding the horrors of a first initiation. To many persons it is undoubtedly a comfort; and, where privation and hardship exist, the comfort is all the more longed for. When hunger and fatigue are being suffered, tobacco undoubtedly affords relief; and where long-continued privation and hardship have been suffered, tobacco is eagerly longed for. The master of a French whaler tells us that, when he rescued eight English sailors, who had subsisted on penguins and shell-fish on a desert island for eighteen months, he offered them whatever was on board his ship; but they did not ask for bread or spirits—they eagerly demanded tobacco, regretting that they had been deprived of its consolatory influence during their protracted misery.

But we cannot stop here. Tobacco, like alcohol and other indulgences, may be, and very frequently is, abused. This abuse inevitably produces injury. And let me now point out what are the injurious consequences of its abuse, and, as far as I can, how they are produced. You may know that there exist anti-tobacco societies and associations, some of which publish the most alarming statements regarding the effects of tobacco, which remind one of the extravagant assertions which were made in the earlier days of its history, such as that it produced a sort of "sooty deposit within the skull-cap or in the brain itself."

The nearest approach to this effect is probably the blackening of the teeth of confirmed smokers, which is undoubtedly a disfigurement that may exert a deterrant influence, especially upon the fair sex.

In confirmed smokers, who occasionally exceed the limits of moderation, there are, however, produced effects which are not only inconvenient, but detrimental to health.

It causes in them disagreeable symptoms in connection with the nervous system, such as headache, sleeplessness, depression of spirits, want of steadiness, with tremors in the arms and legs, and distressing itchiness of the skin, from which they suffer especially when lying awake and unable to sleep in bed.

The circulation of blood becomes affected. They suffer from palpitation and giddiness, the pulse becomes irregular and weak, and the heart does not contract properly. When the pulse is carefully examined it is found that every now and then one of the pulsations is missed out. This change in the circulation causes much anxiety to those in whom it occurs. It is a very common symptom in habitual and excessive smokers. Only a few days ago I saw a gentleman in whom it was very distinctly present, and was accompanied with breathlessness, faintness, and distressing pain in the chest over the heart, shooting from there sometimes to the throat, and sometimes to the arms. He suffered frequently from these attacks, and each time felt as if he were about to die.

I have said that breathlessness is one of the accompaniments of the bad effects of smoking upon the circulation. This is well known to men who are in training for athletic contests, and it is the invariable custom with them to refrain altogether, or almost altogether, from smoking; for they know very well that if they do not refrain they would have a poor chance of winning a race. Now, apart from the bad action upon the circulation of blood, there is very good reason why those who require to keep their "wind" in good condition should not smoke. The smoke of tobacco irritates the back of the throat, and the air tubes which go to the lungs from the throat, and produces there an inflammation which, because it lasts a long time, is called a chronic inflammation. This inflammation thickens the inside lining of the throat and air tubes, and also causes it to be covered with a thick glairy fluid, and, of course, the result is that the tubes are narrowed, and air passes through them less easily than it should. The consequence may be that a form of sore throat is produced, which is sometimes called, "Smoker's sore throat," and you sometimes recognise it in public speakers by the frequent hawking cough with which their eloquence is interrupted.

Inveterate smokers generally suffer also from indigestion. They have poor appetites, and the food they take torments them. When they rise in the morning they do not anticipate breakfast with any relish, for their tongues are dry, and covered with a grey fur, and they are not hungry, as everyone should be in the early morning. The consequence of the disorder of the digestion is that the body is not properly nourished. The inveterate smoker is pale faced, or has a sallow appearance, and when the blood—the fluid by which the body is immediately nourished—is examined, it is found to be of poor quality. The small red cells and the colouring matter in it, which have been described to you in a previous lecture, are not present in sufficient quantity. In fact, a disease exists which we physicians are in the habit of calling anaemia, and which is always accompanied with inability for work, even when the work is of the lightest description, and also with palpitation, giddiness, and faintings.

Tobacco smoked to excess also injures the sight. It does so directly by the irritating smoke coming in contact with the eyes, and producing inflammation. It does so also, indirectly, by the action of the tobacco on the nervous system. The latter is the most serious injuring, for it produces dimness of vision and even blindness, which is difficult to cure.

Now, all these bad effects to which I have drawn your attention are much more easily produced by smoking in a close, confined room, than in the open, outside air. Those who smoke know very well that they are extremely likely to suffer, even after moderate smoking, if that has been indulged in in a close room, along with a number of companions, who were also smoking. This is to be explained by the air in the room becoming saturated with tobacco smoke, so that the air breathed is not pure air, but air containing smoke from each of the smokers, who are subjected to the advantage or disadvantage of inhaling the smoke emitted by all the smokers. Companionship in smoking within doors is, accordingly, anything but an unmixed advantage. It is a frequent cause of illness in moderate smokers, even when it occurs in a large and not otherwise overcrowded room. It is a much more frequent cause of illness in the confined smoking-carriages of railways; and its deleterious influence is every day shown in the suburban railways of the larger cities, and I fear will become manifest here, as an evil accompaniment of many advantages, when the proposed suburban lines are in operation. Those who have had occasion to travel in the outskirts of any of the large cities, such as London, or Manchester, or Glasgow, must have been struck by the evil effects which are produced in the crowded smoking carriages, conveying from the outlying towns persons of all classes into the business centres. Persons not only of all classes but also of all ages; and in connection with this let me point out that if excessive or even moderate smoking in a confined atmosphere, is peculiarly injurious, it is especially so to young persons. Smoking to any extent is productive only of injury to the young. This was some years ago recognised in France, where the Minister of Public Instruction forbade the use of tobacco and cigars by the scholars attending the colleges and schools throughout the whole kingdom, on the ground "that the physical as well as the intellectual development of many youths has been checked by the immoderate use of tobacco." The special evils have been carefully investigated by a French writer, Dr Decaisne, who expresses his conviction that whatever doubts may exist regarding the pernicious effects of tobacco-smoking in adults, they are incontestable in children. He found that in the young even its restricted use quickly produces dyspepsia, sluggishness of intelligence, and deterioration of the blood, that disease which I have already described as anaemia. He also found that the anaemia cannot be cured so long as the smoking continues. I need say no more to convince you, that you will do much good if you exert your influence and authority to prevent children and youths from smoking; and you will perhaps sympathise with me when I express the opinion that the habit is far too often observed among boys on our streets, and that good would be done by the exercise of deterrant discipline, not only by parents, but also by the municipal authorities.

It would appear also that women are, like young persons, specially susceptible to the bad effects of tobacco. I need not, however, dwell on this susceptibility. The women of this country are not addicted either to its use or abuse. A short, well-seasoned cutty pipe may, now and then, be seen in the mouth of a female inhabitant of the Cowgate or of the Canongate; but I have generally found, on inquiry, that that inhabitant was not a *native*, but an immigrant from the sister isle.

Such, then, are the pernicious effects of tobacco, and every moderate smoker is liable to suffer from them. Whenever any of them occurs, the moderate smoker will consult his own interest if he either at once ceases his indulgence, or greatly reduces it; for although most of the bad effects quickly disappear if the immoderation ceases—and in this respect contrast most favourably with the bad effects of immoderation in alcohol—during their continuance they injure health, and interfere greatly with the performance of work.

Some persons are unable to tolerate the smallest quantity of tobacco, and smoking produces only bad effects upon them. Others escape any injury, and consider that they are even benefited by tobacco. They escape injury because they are able to exercise self-control, and so ensure moderation. Such men may attain a ripe age, though few can hope to be so successful in this respect as the famous Dr Parr, who indulged in tobacco to an extent that would for most persons constitute immoderation, and nevertheless lived until he was seventy-eight years of age. The majority of moderate smokers can, however, rarely avoid occasional or frequent immoderation; and as the years pass, the evil effects of each excess would appear to accumulate, or the tolerant powers of the body to diminish. In my experience this has often manifested itself in moderate smokers about their fortieth year of age; and if they are wise, they then cease, or greatly lessen their smoking.

APPENDIX.

THE USE AND ABUSE OF ALCOHOLIC STIMULANTS AND TOBACCO.

ALTHOUGH the proper *use* of alcoholic stimulants and of tobacco may be productive of some good, their *abuse* must be placed among the chief vices of the present time.

ALCOHOLIC STIMULANTS are such beverages as whisky, brandy, gin, wine, porter, and beer. They all contain "spirit." This spirit is alcohol. When it is mixed with a little water, it is called "spirit of wine;" and when it is mixed with about an equal quantity of water, and some flavouring, colouring, and sweetening substances, it constitutes the "spirits" whisky, brandy, gin, and rum. The other alcoholic stimulants contain less alcohol and more water than whisky. In small quantities, alcoholic stimulants improve digestion, and increase the quantity of blood sent to the surface and to many of the organs of the body. In this way, they may do some good to persons who have weak digestion, and to persons who are exhausted or suffering from fatigue; but in weak digestion, a carefully arranged diet and proper medicines, and in fatigue, warm tea or coffee, or beef tea, are much more valuable, and much less dangerous than alcoholic stimulants.

When the quantity of blood at the surface of the body or in the stomach is increased by alcoholic stimulants, the person *feels* warmer, but is really very little if at all warmer; while the mere fact of the surface blood-vessels containing more blood than they should, hastens the cooling of the body, because the surrounding air is always colder than the blood. These stimulants, therefore, do not heat, but make colder any one who takes them on a cold day, and they make one less able to withstand the bad effects of exposure to cold. When the quantity of blood sent to the brain is increased, brain-work seems to be made easier, but nearly always the quality of the work is deteriorated.

Alcoholic stimulants can help in nourishing the body by acting as food. When, however, they are used along with a sufficient, and much more, with a too large quantity of food, they in a short time produce dyspepsia, excited circulation, indisposition for work, and other undesirable effects. They are, besides, very expensive foods, and it has been proved that men can do continuous hard work better without than with them. In children, they are particularly hurtful, because they interfere with the growth of the body, and accustom them to what is very often productive of after misery.

When frequently taken in rather large, or even moderate quantities, they produce a great many diseases, by making important organs and parts of the body unhealthy, such as the stomach, liver, kidneys, brain, and blood-vessels. For this reason, the immoderate consumption of alcohol very decidedly shortens life.

In large quantity, they produce also intoxication, which is not only in itself a degradation, but also the cause of much crime and misery. A single very large quantity is strongly poisonous, and may kill in a short time.

TOBACCO is made from the leaf of an American plant called *Nicotianum Tabacum.* It was first used in this country in the 16th century, and is now very largely used in every known country throughout the world. It is used by smoking, chewing, or snuffing. Snuffing causes the weakest effects, chewing the strongest, and smoking effects intermediate between the two.

The smoking of two or three pipes has been sufficient to kill a person unaccustomed to tobacco, while the smoking of seventeen or eighteen pipes continuously, has killed a person accustomed to tobacco.

The effects of tobacco depend on an oily substance and a very poisonous liquid, nicotine, which are present in the leaves; and when tobacco is smoked, they enter the mouth along with some other substances produced by the burning.

Moderate smokers find that smoking soothes them when they are excited, refreshes them when they are fatigued, and helps them to digest food, to do brain-work, and to bear hunger and privation.

Excessive smoking, and even occasional immoderation, are hurtful to the nervous system, the circulation, the respiration, the digestion, the eyes, and the nutrition of the body.

Injury to the *nervous system* is shown by the production of headache, sleeplessness, depression of spirits, and want of steadiness, along with tremors in the arms and legs.

Injury to the *circulation* is shown by the production of palpitation, giddiness, and irregularity and weakness of the pulse.

Injury to the *respiration* is shown by the production of breathlessness, bad "wind," and "smoker's sore throat."

Injury to the *digestion* is shown by the production of loss of appetite, heartburn, sickness, and a foul tongue.

Injury to the *eyes* is shown by the production of sore or inflamed eyes, and, sometimes, of blindness.

Injury to the *nutrition of the body* is shown by the production of paleness or sallowness of the face, and a bad quality of the blood, which is called anæmia.

All of these bad effects are intensified when the smoking takes place in a confined room, or in a railway carriage, in which several persons are smoking. The air then becomes very rapidly impure; and, further, each smoker breathes in some of the smoke from the pipes or cigars of his companions, in addition to what he breathes in from his own pipe or cigar.

Smoking to any extent is productive only of injury to young people. It checks their physical and mental growth; and is more likely to produce in them a bad quality of the blood than even in adults. Children and youths should be prevented from smoking by those who have authority over them.

Nearly all regular smokers become more easily injured by tobacco as they grow older. After the age of 40, they are very likely to suffer from indigestion, palpitation, and giddiness, and they should then either greatly diminish their smoking or altogether stop it.

PREVENTABLE DISEASES AND THEIR CAUSES.

BY DR SMART.

On the Evening of Saturday, 5th February 1881, Dr Smart delivered the tenth and concluding lecture of the Course of Health Lectures in the Free Assembly Hall, his subject being "Preventable Diseases and their Causes." Dr Smart said :—

LADIES AND GENTLEMEN—

The title of this lecture is "Preventable Diseases and their Causes," and I have chosen it to indicate as nearly as possible the nature of the subject I have to speak of. Under this title we include, for the present, only such as come under the head of Zymotics—that group of diseases, viz.: which are more directly affected by public measures of prevention, and by the conditions which affect large communities. Many other diseases which are, strictly speaking, preventable, such as arise from noxious trades and unhealthy occupations, are not here included, but will, I trust, at some future time, form the subject of an interesting and useful lecture to you. A preventable disease may be described as one which arises or spreads in consequence of the wilful, careless, or ignorant violation of those laws, the proper observance of which we know to be necessary to insure the preservation of health, and avert the spread of disease.* Those diseases—a very numerous group—which result from personal vices or from depraved habits of the community, are beyond the immediate control of public measures.

The chief of the zymotic diseases are :—smallpox; typhus fever; typhoid (or enteric fever); scarlet fever (or scarlatina); diphtheria; measles; and Asiatic cholera. We will consider them from the following points of view: *first*, the injury they inflict; *secondly*, how they originate; *thirdly*, their distinctive characters; *fourthly*, the conditions under which they spread; and *fifthly*, the means necessary for their control and prevention. "It seems certain," writes Mr Simon, Medical Officer to the Privy Council, "that the deaths which occur in this country are fully a third more numerous than they would be if our existing knowledge of the chief causes of disease were reasonably applied throughout the country; that of deaths which, in this sense, may be called preventable, the average yearly number in England and Wales is about 120,000, and that of the 120,000 cases of preventable suffering which thus in every year attain their final place in the death register, each unit represents a larger or smaller group of other cases, in which preventable disease not ending in death, though often of far-reaching ill effects on life has been suffered. . . . Then there is the fact that this terrible continuing tax on human life and welfare, falls with immense over-proportion upon the most helpless classes of the community; upon the poor; the ignorant; the subordinate; the immature; upon classes which, in great part through want of knowledge, and in great part because of their dependent position, cannot remonstrate for themselves against the miseries thus brought upon them. And have, in this circumstance, the strongest claim of all claims on a legislature which can justly measure and can abate their sufferings."*

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* Grimshaw.

"Diseases of this class," says Dr Farr, the Registrar-General, "distinguish one country from another, one year from another. They have formed epochs in chronology; and, as Niebuhr has shown, have influenced not only the fates of cities such as Athens and Florence, but of empires; they decimate armies, disable fleets; they take the lives of criminals that justice has not condemned. They redouble the dangers of crowded hospitals; they infest the habitations of the poor, and strike the artizan in his strength down from comfort into helpless poverty; they carry away the infant from the mother's breast, and the old man at the end of life; but their direct eruptions are excessively fatal to men in the prime and vigour of age." These weighty words of the two greatest living authorities on this subject ought to be well pondered.

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* 13th report of the Medical Officer of the Privy Council.

Mr Simon reckons the deaths from these diseases at 120,000 in England and Wales alone. If we add those in Scotland and Ireland, from the same causes, the total mortality is over 150,000, every one of which is a needless death. Does this not strike you as a frightful waste of life? If we now compute that each one of these deaths represents, at a moderate estimate, thirty instances in which there is loss of health short of death, the aggregate of needless death and suffering becomes perfectly astounding, and affords a sufficiently cogent reason why zymotic diseases are specially singled out to be dealt with by stringent enactments having for their object their prevention, and ultimately total extinction.

THE GERM THEORY OF INFECTIOUS DISEASES.

HOW THEY ORIGINATE.—The term Zymotic is applied by those who believe that in these disorders there takes place a process which bears a striking resemblance to that of fermentation. This resemblance was first pointed out by Leibig. Thus, when yeast is added to a solution of sugar, the yeast cells rapidly multiply by feeding on it—alcohol and carbonic acid being given off during the process. Yeast, I should tell you, is a rudimentary plant composed of cells, which, when placed in a suitable medium, actively multiply, living at the expense of the medium in which they exist, and ultimately changing its character. (See Diagram.) This is fermentation, as it occurs outside of living bodies, and is the starting-point of the idea that germs of different kinds—animal and vegetable—are the active agents in the production of zymotic diseases. That these germs *do* exist abundantly in the air, and elsewhere, has been proved by the experiments of many observers, and especially by Pasteur, a French physiologist. [Here describe and show Pasteur's experiments with air and liquids in sealed flasks.]

Pasteur found by experiment that certain changes which sometimes take place in beers and wines, during the course of preparation for use, and which he calls "diseases," are owing to the presence of vegetable germs, every particular change being due to a different kind of germ. Another investigation, which he undertook at the earnest entreaties of his friend and preceptor Dumas, the celebrated chemist, resulted in a discovery which throws interesting light on the same subject, by showing how animal germs may be the cause of a disease among animals of a very destructive and infectious kind. France, a few years ago, was threatened with a great calamity. For fifteen years a plague had raged among its silkworms. In 1852 the silk culture of France yielded a revenue of 160,000,000 of francs; ten years later it had fallen to 4,000,000. Pasteur found that the bodies of the silkworms which had the disease were infected by minute corpuscles, which, taking possession of the intestinal canal, spread thence throughout the body. They filled the silk cavities, the stricken insect often going through the motions of spinning without any material to answer to the act. The organs, instead of being filled with the viscous liquid of the silk, were packed to distention by these corpuscles. On this feature of the plague Pasteur fixed his whole attention, and brought the inquiry to a triumphant issue! By inoculating the healthy worms with the corpusculous matter, he found the disease to be highly infectious. He further showed how the silkworms infected one another by inflicting wounds upon each other by means of their claws. He washed the claws, and found the infecting corpuscles in the water. He next spread the infection by simply bringing the healthy and diseased into contact. The diseased worms sullied the leaves of the mulberry tree among which they spin, and by their dejections spread infection in both ways.*

These observations exemplify in the most striking manner what actually takes place in some of our own zymotic diseases.

Whatever be the difference of opinion as to the precise nature of the infecting elements in these diseases, whether they be the rudimentary forms of animal or vegetable life, or merely particles of our own bodies which have acquired a poisonous property which does not naturally belong to them, most are now agreed, I think, that such particles have a veritable existence.

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* (Tyndall—"Dust and Disease.")

With the limited time at my disposal, I can but give you the briefest account of the proofs that have recently been accumulating in support of Pasteur's views, besides those of many other observers,* that *that* something by means of which infecting diseases pass from one to another, has a real existence, is an organised solid, however minute, which is the absolutely indispensable agent in the transmissibility of these diseases. These opinions mark a great advance in the medical views of the past few years. The phantom of what used to be called an "epidemic constitution of the atmosphere" has ceased to haunt us, while sanitary and medical science are more and more mustering their resources for the utter destruction of those invisible potentialities which are everywhere about us, "both when we sleep and when we wake." Let me illustrate what I have said by means of these diagrams. You see those particles; they are so minute as to require the aid of a powerfully magnifying lens to bring them into view. They are obtained by filtration from vaccine lymph, which appears to our unassisted eye to be a clear fluid. If the lymph without the particles be used to vaccinate, it entirely fails; but if the particles be used without the fluid, it perfectly succeeds. You will better understand what I mean when I tell you that a person undergoing vaccination, is passing through a mild or modified form of small-pox. These particles may be therefore regarded as the virtual agents in the production of small-pox. Similar particles perfectly alike in outward form exist in the lymph of Glanders or Farcy, a most virulent disease which attacks horses, but is communicable to man. A horse inoculated with the fluid, without the particles, would escape, but not if it contained the particles.

In this other diagram you have a view of infecting germs derived from the vegetable kingdom (Bacillus anthracis), namely, the rod-like fungus of anthrax, a fatal disease, chiefly attacking animals such as the horse and ox, and sometimes man. These infecting particles resemble, as you see, minute rods. They grow into fibres, then fructify, each one producing a number of spores, which are the oval bodies seen in the diagram. In this disease, these germs infest the tissues and blood of the infected animal or person, and live, grow, and multiply at the expense of the tissues and blood. If now the blood containing these rods and spores be filtered, it becomes harmless, that is, it will not infect another animal. But, on the contrary, these bodies will cause the disease in its most virulent form.

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* Obermeyer, Klebs, Chaveau, Burdon Sanderson, Lister, Greenfield.

This diagram shows a drawing of a section of skin in erysipelas, an infectious disease of a rapidly spreading nature, characterised by great inflammatory swelling and redness (hence named St Anthony's fire). The dotted portions indicate the lymph vessels and spaces, the dots representing minute vegetable spores (micrococci) crowding the spaces. There is no longer any doubt that diphtheria is a disease essentially due to the presence of similar parasitic organisms.

This other diagram furnishes an example of another kind. It exhibits the spirilla of relapsing fever,* sometimes called famine fever, from its occurrence during periods of scarcity. You readily distinguish the organism existing among the blood-corpuscles by its spiral or corkscrew appearance. This fever relapses for a week, then suddenly re-appears for a week, and so on, hence its name. The spirilla is found in the blood when the fever comes on, and disappears when it goes off, and finally disappears, when the sufferer recovers—thus proving its connection with the disease.

Another discovery has lately been made by Professor Klebs throwing much interesting light on the causation of marsh or malarial fever. He found a species of vegetable organism existing in the air of the Pontine marshes, which, when injected under the skin, produced that fever. Further proof of the connection of these organisms with malarial fever is found in the fact that they are present in the organs, and in the blood of persons who die of marsh fever.

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* Obermeyer.

I found rod-like germs abundantly present in the blood of animals attacked with cattle plague, one of the most intensely infectious diseases that ever visited this country. They are delineated in my reports on the subject to the Authorities. So far as I am aware, it was the first time that they were shown to exist in the blood of living animals.* A few facts will better enable you to comprehend the enormous fertility of germs and spores.

Among the larger animal germs, which are visible to the naked eye, and may therefore be counted, the late Mr Buckland found no fewer than seven millions of eggs in a single cod-fish. The Ascaris, an intestinal worm infesting man and other animals, produces about sixty-four millions of eggs; and in the vegetable kingdom some single plants yield over seventy-four millions of seeds in a season. Numerically great as these figures are, they are dwarfed by the greater productiveness of the spores of some fungus plants. They are inconceivably minute—two hundred millions, side by side, would not cover a square inch—yet they possess an inherent vitality, which, under favourable circumstances, will burst into life, reproducing the parent plant from which they sprung. Again, we are told that spores, equal in number to the entire inhabitants of the globe, placed side by side, may easily rest on a space four inches square; and that one million would find ample accommodation on the head of a pin!

Professor Tyndall was the first, I think, to make these facts, viz., the presence of particles in the air, palpable to our senses by an experiment which you can all make for yourselves. He let a sunbeam into a darkened room, through a chink or hole in the shutter. The bright ray revealed the floating dust—for it is a fact that without dust there would be no visible ray. It is the particles of dust that intercept and scatter the light and make it visible to us. A similar effect is produced when a bright ray, for example, from the electric light, or lime light, is thrown across a darkened room. When the flame of a spirit-lamp is then placed under this ray it gives the appearance of smoke passing through it, but there is no smoke from the spirit-lamp, and the black space is produced by the heat of the lamp burning the particles floating in the luminous beam, and for the time being rendering that part void, or empty of particles. The black spot thus produced is said in scientific phrase to be "optically empty."

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* September, 1865.

The experiment may be turned to practical and really useful account, by showing us that these particles may be prevented from entering the lungs. Thus, a handful of cotton is placed against the mouth and nostrils, and a full breath inhaled through it, which is easily done. The cotton is now removed, and the air in the lungs made to pass through a glass tube into the luminous ray, when a dark smoke-like space is seen, as in the previous experiment with the spirit-lamp. This shows that the air is filtered of its particles by passing through the cotton.

DISTINCTIVE CHARACTERS OF INFECTIOUS DISEASES.

Accepting, as we do, the theory that each case of infectious disease originates in the reception of a distinctly specific, pre-existing poison, and that it in turn becomes self-propagating, we now go on to speak a little in detail of each of these zymotics. There are some features which are common to the whole group. They all, for example, begin with a period of what is called "dormancy" or "latency" or "incubation," during which the poison is actively developing. But the duration of this period differs in each case. That of smallpox is twelve days; typhus fever, eight to fourteen days; typhoid fever, fourteen to twenty-one days; scarlet fever, three to six days; measles, about four days. These differences in the length of the incubation period being probably due in each case to the amount and strength of the poison received. At the termination of this period, the sickness is said to begin, although its distinctive character may not appear for some days longer. These fevers are all ushered in by a marked, and sometimes sudden, elevation of bodily temperature, which, with variations, continues during the course of the illness. It is because of this increased temperature that they are called fevers. Characteristic eruptions now appear. Scarlatina on the second, measles on the fourth, and smallpox on the third day, and so on. Now begins the infecting period, which increases with the activity of the disease.

SMALLPOX.—The patient is now charging the air, and everything about him, with a most subtle and deadly virus, derived chiefly from the skin and mucous membranes, but not restricted to them. There is no contagion so strong and sure, or that operates at so great a distance, passing from house to house, from street to street, making sanitary precautions difficult. I regret to add that cases of this disease, imported from London, are already here.

TYPHUS FEVER once contracted is highly infectious, and essentially a disease of over-crowding and foul air from deficient ventilation, associated with squalor and want, and a deteriorated constitution from whatever cause. It chiefly infects by exhalations from the skin and lungs. The patient's bedding and clothes become saturated, and the poison clings so persistently to the walls, and to everything in the room, as to make the destruction of the latter in many cases necessary.

TYPHOID FEVER differs from the preceding in its being but slightly, if at all, infectious through the air. Here the seat of the attack is the intestinal canal chiefly, and the poison is mainly eliminated by that channel. It is accordingly the intestinal discharges, and clothes or bedding tainted with them, that have to be mainly looked to, and every precaution taken by disinfection and removal, to prevent their access to water sources, such as wells, or into house drains; where, by decomposing, they infect by their effluvia. These discharges acquire their maximum infective power when decomposing.

Asiatic Cholera.—We are fortunate in this country in being rarely visited by this Oriental epidemic. The precautions are the same as in typhoid fever—the source of danger being alike in both cases. It is astonishing how small a quantity of intestinal discharge in these disorders, especially in cholera, will taint the water supply over a large area, which may mean death to thousands. Dr Farr estimates that in cholera, if these fluid discharges contain infecting particles in the same proportion as blood corpuscles exist in healthy blood, forty-two millions of them would be set adrift during the progress of a single case.

Scarlet Fever.—There is perhaps not any other illness that you are all more painfully familiar with than this fever. It is a household experience, a troublesome one, which is regarded very much as inevitable.

Although no age is exempt, it is essentially a children's illness —attacking mostly between the ages of three and four, and the risk lessens after the fifth year. Its poison is most active and penetrating, and retains the power of infecting for indefinitely lengthened periods. As nearly all the fluids and tissues participate in the attack, they may all infect,—the skin by casting its outer surface, the internal membranes by a like process, tainting the secretions. Isolation, that is separation, is a necessary part in the treatment of this fever. The worst cases are associated with malignant sore-throat, which so far brings it into relation with another very infectious malady, viz., Diphtheria, the seat of which is chiefly the throat and upper air passages, and the infecting channels, the breath and expectoration. I have said that these disorders are all marked by increased bodily heat. This is, however, but one of the many symptoms which signalizes their course. In most the heart's beats are doubled; the blood courses along the vessels with redoubled velocity; the respirations are doubled. The whole vital machinery is working under its highest possible pressure. Bodily waste is more than doubled. In ordinary health our bodily substance breaks up, and is parted with at an expenditure equal to several pounds' weight per day; but during the febrile state health limits are vastly exceeded.

I leave you to draw your own conclusions as to the consequences which must follow to others, when this enormous amount of infective material is daily set adrift—for we must remember that our waste and *effete* materials, under these conditions, become charged with the virus of the disease !

I wish now to say a few words on what has been fittingly named—

THE BREEDING PLACES OF INFECTIOUS DISEASES.

For this purpose I select some of those localities from which these diseases are never altogether absent, and from which they usually go forth upon the rest of the community. Examine with me for a little these diagrams:—Of these six columns, the shortest represents the healthiest district, the tallest the unhealthiest, showing the extreme of six districts existing in different parts of a neighbouring city. The upper portion of each column represents the number of deaths from the infectious diseases which occur in each of these districts; the middle portion, the number of deaths resulting from pulmonary diseases, mostly consumptive; the lower portion, the deaths from what is called "unclassified" diseases. Now, notice that the rate of deaths steadily increases; thus, in the district represented by the shortest column, the inhabitants are aggregated together in the proportion of thirty-five persons to every acre of it, and its death-rate is nineteen persons per thousand annually. In the next they are aggregated together in the proportion of four hundred and twenty-six persons to every acre; and its death-rate is thirty-five persons per thousand annually. In the third, their aggregation is in the proportion of four hundred and fifty per acre, with a death-rate of thirty-eight per thousand. The fourth, the proportion is three hundred and fifty per acre, and the death-rate forty-one per thousand. The fifth is, three hundred and fifteen per acre, and a death-rate of forty-three per thousand; and, sixthly, in the highest column, they are aggregated together in the proportion of five hundred and eighteen, with the death-rate of forty-five per thousand. The fourth and fifth are only *apparent* exceptions to the rule of an increasing death-rate with an increasing density of population. The inhabitants of these districts, although fewer, are more densely huddled together.

Look now, for a moment, at the composition of each of these columns, and you will observe that the death-rate from infectious diseases, not only steadily increases with the density of its population, but also that from pulmonary and "unclassified" diseases. These groups are represented in different colours, and will assist you to form a juster conception of the dangers resulting from over-crowding.

The credit of working out, and applying this important law of death-rate to density, belongs to Dr Farr.

Taking the five hundred and ninety-three registration districts into which England and Wales (not including London) are divided, he arranges them into so many groups according to their densities, beginning with the most thinly populated rural district, with only a hundred and sixty persons to the square mile, and ending with the most densely packed town districts, as Glasgow and Liverpool, with over sixty thousand on each square mile. Let us now, with the assistance of these other diagrams, note the results.

In the district with 166 on each square mile there is a death-rate of 17 p. 1000
,, ,, 379 ,, ,, ,, ,, 22 ,,
,, ,, 1718 ,, ,, ,, ,, 25 ,,
,, ,, 4499 ,, ,, ,, ,, 28 ,,
,, ,, 12,357 (Manchester) ,, ,, 38 ,,
,, ,, 66,000 (Liverpool) ,, ,, 39 ,,

Glasgow, with a density of population nearly similar to that of Liverpool, has a much lower death-rate, thanks to the enlightened exertions of its able health officer.

How comes it then, that persons living in thinly-peopled rural districts (165 to the square mile), die annually in the proportion of 17 per 1000, while those of Liverpool perish in the proportion of 39 per 1000? What is the cause of this greatly increased mortality? I cannot answer this question better than by quoting the words of the accomplished Medical Officer of Glasgow, Dr Russell, to whom I have just referred: "Density," he remarks, "means, in relation to Glasgow, that three-fourths of those human beings live in houses of one and two apartments, that those houses are built in tall tenements, so arranged on the earth's surface as to exclude the sunlight and impede the circulation of the air, more especially that a large proportion of those tenements are arranged in hollow squares. . . . It means that inside those boxes there are ash-pits, . . . that planted among those ash-pits we have hundreds of 'back lands,' along with stables, byres, bake-houses, work-shops, washing-houses, and other smoke and effluvia producing erections, that the stairs are often close and badly ventilated, that they are at best vertical streets, with lanes and alleys branching off at the several landings. . . . It means that hundreds of factory chimneys and thousands of domestic vents, maintain over all this devoted area a dense canopy of smoke, which in summer cuts off a large proportion of the sun's rays, an extra supply of whose decomposing energy ought if possible to be secured to aid in the destruction of the organic particles which are so rife in the air of cities, and which, in the winter, descend upon us with the watery vapour of our fogs. . . . Our rivers and streams are loaded with the foulest refuse, that the subsoil is traversed by a net-work of sewers, drains, and gas-pipes, and is therefore so impure that the ground air is loaded with noxious effluvia, and the ground water is so foul that to drink it would be poisonous, if, indeed, it could be done.

"Finally, it means that for grassy fields we have stony streets, and in place of trees we have lamp-posts, and altogether we are as far shut out from the ministry of nature as the necessities of the case, combined with the aggravations of human ignorance, perversity, and wilful self-aggrandisement, can place us."

We have now to speak of

THE CONDITIONS UNDER WHICH INFECTIOUS DISEASES SPREAD.

The Carriers of the Infection.—We have seen how readily infecting germs may be dispersed, wafted by the air, carried by water, tainting our clothes, our money, and the commodities given in exchange for it. The mutual dependence of class upon class, and their unavoidable concourse, the relationships of life, as well as its vicissitudes and necessities, all tend to bring people together—in short, the entire machinery of society such as we find it, is peculiarly adapted to spread infectious diseases.

There can be little doubt that the spreading of these diseases, in the majority of cases, is brought about by the healthy coming into contact with the sick or convalescent. Children after an attack, are allowed to go back to school too soon, and the result is renewed outbreaks of scarlatina, measles, and whooping-cough. The laundress disseminates the poison of scarlatina and smallpox amongst her employers; nurses carry it from sick-beds to their own homes; the tailor and dressmaker often ply their needles close to fever-stricken patients. One doctor writes that he has seen the garments, which were thus being made at their homes, used to eke out the scanty bed-covering of a fever patient; another, that he received a patient into hospital with smallpox pustules on him, who had on the previous day been occupied in dressing ladies' hair. I myself lately entered a house of one room with eight occupants, five of whom were laid down with scarlatina. In the midst of this, the father, an enfeebled man, was trying to earn a little money by working at a couch which ere many days would too surely carry disease into some household. These persons have our deepest sympathy, and if we speak of their hard necessities, it is in the hope, and with the earnest wish that we may be able to mitigate, or remove them.

Let us vary the illustration by another example. The milk-cans, we shall suppose, at a farm-dairy have been unwittingly washed with water contaminated with sewage; or, perhaps, a little of that element has been added to improve its quality!—then follows what is significantly called "the trail of the milk-man"—a trail marked by fever cases in perhaps every house to which the milk has been distributed.

Or there is a fever at one of our town dairies, in the back-room of the shop, for example, and the attendant on the sick also attends to the customers, who carry the milk to their homes, and with it the germs of future disease. This diagram will assist you to realise more vividly what I have just said. It represents a farm-house in which typhoid fever has arisen, by the milk becoming tainted in the way I have spoken of. This dot marks the first case which arose in consequence.

Observe how the disease spreads from this starting-point. This other dot shows the second case, which arose in nineteen days from the first, and this, the third, in twenty-six days from the first —all in the same house; but in fourteen days from the first case, a group of three cases occurred in a family, supplied with milk from this farm, and within eight weeks from the first case, a hundred and sixty-six persons were laid down with the fever.

Look now at this diagram, illustrating the growth of an epidemic of scarlet fever, from a single case.

It is a moderate estimate of the rate of progression of this fever, to say that each case produces two others. Follow these dots from the starting case, and in seven weeks from its commencement, you will see that the one case has multiplied into two hundred and fifty-six. Once more, study with me this diagram marked cholera. I have said that this disease is propagated by water, fouled by choleraic discharges. Estimating that each case produces five others, a ratio which may be taken as considerably under its usual rate of progression, there would arise six hundred and twenty-five cases within eight days. Several instances of this actually occurred during the cholera epidemic of 1866.

The presence of an epidemic of small-pox in London, and the certainty of its early advent amongst ourselves, lead me to invite your very special attention to this other series of diagrams, which exhibit in the most convincing and instructive manner, the influence of vaccination in preventing and modifying that disease under different conditions and periods of life. They show the results, based upon a most painstaking and successful investigation, of a thousand cases of small-pox, treated in hospital during 1871, by Dr J. B. Russell. The diagram, as you observe, is divided into large squares, each being subdivided into one hundred smaller squares, so that each large square represents one hundred cases of small-pox. The colouring again, whether black, red, or white, tells you the degree of severity with which each case was affected. Those portions of the squares in *white*, show how many were attacked with the mildest, or *seldom fatal form of the disease* (with rare or sparse eruption). Those in *red* indicate intermediate, or *frequently fatal conditions of the disease* (copious eruption); while the *black* marks the dangerous, or *very fatal type of the malady* (confluent eruption).

The upper row of squares, from left to right, shows the effects of vaccination—between the periods of infancy and adult life—when *well done;* the corresponding middle row, its effects when *badly done;* and the lowest row, when *not done at all.*

By glancing at the diagrams in this order, you will at once observe, that the well-vaccinated, as they grow older, take the disease in a slightly severer form; the badly vaccinated in a much more severe form; and those who have not been vaccinated at all, are *throughout their whole lives*—from infancy upwards—subjected to the very worst and most fatal form of the disease. In other words, you will not fail to draw the inevitable conclusion, "that the influence of vaccination, well and thoroughly done, extends, with but little loss of protecting power, throughout life; while, if badly or imperfectly done, it is never so efficient a protective power, gradually loses what protecting power it had possessed, and finally leaves the badly-vaccinated individual only a little less susceptible than he who has never been vaccinated at all." *

Each of these infectious fevers grows and spreads by conditions peculiar to itself, which depend, to a considerable extent, on the length of its incubation period.

The two first of these diagrams show sufficiently well the manner in which the recent epidemics in Edinburgh of typhus, typhoid, and scarlet fevers began, and spread; as also nearly the numbers affected, and the duration of the epidemics.

We have now to speak of

THE MEANS NECESSARY FOR THE CONTROL AND PREVENTION OF INFECTIOUS DISEASES.

The instructions intended for your guidance in emergencies which I have drawn up, based on my lecture,† are, I understand, already in your hands; and I am thus so far relieved from many details, which it would otherwise have been desirable for me to touch upon. I will ask you then to hold that part of my lecture as read; and I will now proceed in a few brief sentences to enumerate those measures for the effectual control and prevention of epidemic disease which I consider to be necessary.

Firstly, We must aim at the promotion of cleanliness of every description, by the employment of those legal powers contained in public health enactments, which are amply sufficient for the purpose if carried out.

Secondly, At placing all building operations—such as the construction of houses, selection of healthy sites, house and general drainage—under strict sanitary inspection and supervision.

Thirdly, At preventing over-crowding, alike in dwellings or in districts. This measure comprehends the constant inspection of houses, the width of streets, the height of houses, the removal of old and insanitary dwellings, the promotion of open spaces.

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* Lectures on the "Prevention and Control of Infectious Diseases," by Dr J. B. Russell.

† See Appendix.

and the opening up of thoroughfares through dense and insanitary neighbourhoods. Thanks to the efforts of our late Lord Provost Chambers, a good beginning has been made in this direction in this city.

Fourthly, It will be found utterly impossible to prevent infectious diseases without a more stringent act in regard to their registration. *Nothing short of the compulsory registration of these diseases will effect this end.* To prevent their spread it is essential that the authorities should be early apprised of the existence of every case.

Fifthly, Following from this the authorities should be entrusted with the discretionary power of compulsory removal. This power will never be abused; and,

Sixthly,—Such powers imply, and, indeed, necessitate, on their part, the providing of ample accommodation for the reception of infectious diseases, as will suffice to meet the emergencies of epidemics; for the reception of actual cases, convalescent cases, suspected cases; and further, for the reception of patients who may voluntarily desire to be treated in hospital. There are many such, who, though comfortably circumstanced in their own homes, would gladly avail themselves of this provision. It may interest you to know that the late Sir James Simpson expressed his determination to be treated in hospital in the event of his suffering from an infectious illness. All such arrangements would require to be carried out in a liberal interpretation of the acts. For example, the greatest difficulty is experienced in the removal of children, from the unwillingness—a natural one—of mothers to be parted from them during their illness.

Mothers, under certain restrictions, should be admitted to the hospital to nurse their own children.

It is proposed to acquire the ground and buildings of the old Royal Infirmary as a hospital of this kind, under the entire control of the civic authorities. This is a step in the right direction.

We enjoy the services of an able and energetic medical officer, whose heart is in his work—but without such powers and provisions as I have indicated, the best efforts of the authorities and of their medical officer will fail of their object.

I have only, in conclusion, to add that it is most desirable to have our people thoroughly informed in regard to sanitary matters, in order that they may heartily and intelligently assist in promoting what is really necessary for their own and their neighbours' good.

To further this desirable movement has been, I know, the cherished object of the promoter of these "Health Lectures for the People."

At the close of the lecture Dr Smart showed Professor Tyndall's experiments by means of the lime-light.

APPENDIX.

ON PREVENTABLE DISEASES AND THEIR CAUSES.

GENERAL PRECAUTIONS.

1. The following preventable diseases (called also zymotic) are all *infectious.* The chief of these are:—Scarlet fever, typhoid (or enteric fever), typhus fever, smallpox, measles, diphtheria, whooping-cough, and Asiatic cholera.

2. When any of these illnesses (except whooping-cough) enters a household, the patient should be, if possible, at once separated from the rest of the inmates (especially from the bread-winners); the children who are in health kept from school, and as much as possible from mixing with other children.

3. The sick-room to be divested as much as possible of every article of needless furniture, especially of woollen fabrics, such as carpets, curtains, cushions, &c.; to be well ventilated by means of a fire constantly burning, and the strictest cleanliness observed.

4. A large vessel (a tub) to be kept in the room, containing a couple of gallons of water mixed with carbolic acid, in the proportion of one wine-glassful of the liquid acid to each gallon of water. Into this, every article of clothing, bed-clothes, &c., removed from the patient, should be immediately plunged, and kept there for twelve hours, and then washed apart.

5. A basin containing water, having two tablespoonfuls of Condy's Fluid added to it, to be always in readiness for cleansing the attendant's hands, or sponging the patient when necessary. This solution should be renewed when it is seen to lose its bright purple colour.

6. A sheet dipped in the carbolic solution named, should be hung over the door of the sick-room, reaching to the ground, and kept constantly damp by means of sprinkling or a sponge. Only the attendant to enter the sick-room.

7. The dress of the attendant should be of cotton, or of some washable material, with smooth surface.

8. Food that has been in the sick-room, on no account to be used by the other inmates. It is desirable for many reasons, that the attendant do not take her meals in the sick-room.

9. Dishes, and vessels of every kind used about the patient, ought to be thoroughly cleansed before being used by others.

10. *All* discharges from the sick to be received into vessels containing disinfectants (Calvert's or Macdougall's Carbolic Powder), and, if convenient, deposited in the ground to the depth of about two feet. If disposed of by w.-c., it should afterwards be freely flushed with the carbolic solution.

SPECIAL PRECAUTIONS.

SCARLET FEVER.

11. To prevent infection by the particles which peel off from the skin, the patient should be anointed once a-day with carbolic oil, made with one part of carbolic acid, to fifty of olive oil. The efflorescence (or peeling off) is first seen on the skin of neck and arms, and begins sometimes as early as the fourth day. The anointing should be complete, including the head, the oil being freely applied to the roots of the hair. This should be continued for six weeks, a warm bath being given weekly during that time. After this period (six weeks), the patient may mix with the other members of the family; but children should not return to school for two weeks longer.

MEASLES.

12. The same rules as above to be observed, with the addition that the discharges from the mouth and nostrils should be received on cloths which may be destroyed by burning.

TYPHOID FEVER.

13. The poison by which this fever spreads is chiefly contained in discharges from the bowels. These may infect the air of the sick-room, the bed, and body-linen of the patient, and the w.-c. and drains connected with it. If thence they escape to the soil by soaking into wells, they poison the drinking-water. This is a common and dangerous way by which this fever spreads. To prevent such consequences, the discharges should be disinfected on their escape from the body as previously directed. This is the *chief* precaution to be attended to, and if effectually done, removes almost all the risk of infection.

TYPHUS FEVER.

14. This is a much more " catching " fever than the preceding, and is caused by over-crowding and deficient ventilation. It is apt to attack those who are much exposed to it for the first time. It is therefore better to have a nurse who is protected by a previous attack. The poison is thrown off by the skin and lungs and readily infects clothing, furniture, etc. ; so that the chief precautions are those of ventilation and disinfection.

SMALLPOX.

15. The perfect protection from this disease is *efficient vaccination.* This is known by a *good large mark*, or *scar*. Re-vaccination after the fourteenth year is advisable. An unvaccinated case of smallpox in Scotland is so rare, that precautions in regard to it are needless. Should such a case occur, the precautions already named should be most strictly adhered to, as it infects at a greater distance than any other infectious disease.

DIPHTHERIA.

16. Diphtheria poisons by means of the breath and expectoration ; and the utmost precaution to avoid contact with these on the part of those about the patient is absolutely necessary. The expectoration should be received into a vessel containing Condy's Fluid, or on cloths that may be at once burnt ; and the throat frequently gargled with a solution of the same, of the strength of a small teaspoonful to a quart of water. A mother should on no account kiss her children during this, nor, indeed, any of the other infectious illnesses.

WHOOPING-COUGH.

17. Whooping-cough is a disease to which children are more especially susceptible, and most fatal to children under two years of age. It is so extremely fatal to infants, that every effort should be made to keep them out of the range of the infection by separation. The poison comes chiefly from the mucous secretions of the lungs and air passages, and is readily imparted to the clothes of those who nurse the patient. These secretions are infectious from the beginning of the illness.

ASIATIC CHOLERA.

18. This only occasionally visits this country. As in typhoid fever, it spreads by means of the bowel discharges ; and the same precautions are necessary.

GENERAL STATEMENTS.

19. In any of these infectious diseases, where there is not sufficient accommodation for fully carrying out these precautions, it is urgently recommended that the patient be removed at once to the Hospital appointed for the reception of such cases. It need hardly be added, that no time should be lost in obtaining medical advice when any of these diseases appear.

20. We abstain from giving directions as to the disinfection of a house either after death or recovery, as the authorities gratuitously and efficiently do this when applied to ; besides making ample compensation for any articles of furniture, &c., they consider it necessary to destroy.

Edinburgh Health Society.

HEALTH LECTURES
FOR THE PEOPLE.

Illustrated.

SECOND SERIES.

*DELIVERED IN EDINBURGH DURING
THE WINTER OF 1881-82.*

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EDINBURGH
HEALTH SOCIETY.

INSTITUTED 1881.

PRESIDENT.

THE RIGHT HON. THE EARL OF ROSEBERY.

THIS SOCIETY has been formed :—

To promote, *by all means in its power*, attention to personal and domestic Cleanliness, to Comfort, Self-denial, Temperance, and the Laws of Health generally.

The Means to be employed for this end may, in the opinion of the Committee, be stated in the meantime as follows :—

1. The delivery of Popular Lectures bearing on the subjects in question by Physicians and other qualified persons.
2. The printing and distribution of these Lectures, and of small Leaflets.
3. Providing subjects of Interest for the Mind, and encouraging proper Amusements and Physical Exercises.
4. Giving assistance to the Constituted Authorities in the promotion of sanitary improvements by drawing their special attention to any particular insanitary condition.
5. Obtaining the assistance, so far as necessary, of any other Society in the City willing to co-operate in the work of this Society.
6. Arranging for the *re*-delivery of the Society's Lectures in villages in the neighbourhood of Edinburgh, and for the formation in such places of small *local* Committees in connection with the Society.

Members Enrolled and Subscriptions Received by :—

The Honorary Treasurer—ROBERT COX, Esq., Gorgie.
The Honorary Secretary—WALTER A. SMITH, Esq., 24 Hartington Place, Viewforth.
Messrs MACNIVEN & WALLACE, Publishers, 144 Princes Street.

Annual Subscription, ONE SHILLING, or more.
Life Subscription, ONE GUINEA.

PREFACE.

In publishing this volume of Lectures, delivered in connection with the Edinburgh Health Society, the Committee of Management think it will be interesting to the Public to refer to the work which has been done during this, the first session of the Society. In the first place, this work has consisted in the delivery of the lectures now printed. These lectures were listened to by large and attentive audiences, numbering on an average two thousand, and the Committee feel sure that many important hints were given in them, and they trust that these hints will be made use of by those who heard them, and also by many more who may now read them. The Committee and the Lecturers have been much gratified with the very large numbers of the working classes who have attended the lectures, as evincing the interest taken in them by those for whose benefit they were chiefly intended; and they have also been pleased with the orderly behaviour and the great courtesy which has been shown on all occasions, without exception, to them, to the Chairmen, and to all connected with the Society.

The second work carried on by the Society, principally through the Committee, has been to make arrangements for the *re*delivery of these lectures in some of the smaller towns in the outskirts of Edinburgh, showing that the interest in this Society is not confined to Edinburgh, but is extending outside of it. It may perhaps interest some to know that an application has been received from Iceland to have the lectures sent there in order that they may be translated into the language of that country and made useful to the inhabitants.

The third work done has been to consider and discuss many important questions in connection with health and sanitation. In regard to some of these questions, it was decided that it was better not to interfere, and in regard to others, information is still being sought. The Committee wish it to be understood, that the object of the Health Society is not to come into collision with the authorities, but rather to co-operate with them. It does not wish to embarrass or to force legislation; neither do its members wish to make themselves disagreeable in any way. All they want to do, is to educate the public to observe and work for themselves; and the Committee hope, that in time, it will not be necessary for the Society to go to the Public, but that the Public will come to the Society and ask them to assist them in connection with many important health matters.

With reference to the financial condition of the Society, the Committee are glad to say that, so far, the money obtained has been sufficient to meet all the current expenses. The Committee desire it to be distinctly understood, however, that the Lecturers have not only given their services *free*, but that many of them have most kindly been at considerable outlay in providing illustrations for their lectures. The expenses have been only in connection with the hall, and in paying for advertising and printing. Up to this time, 207 members have joined the Society. Considering the large audiences who have benefitted by the Lectures, the Committee consider this number rather disappointing, and they trust that it will soon be largely increased. It entirely depends upon the support given, not only of money but of influence, what amount of good the Society can do. The Society is very anxious to do a great deal. It is very anxious, for instance, to provide proper means of Amusement for the People, such as a suitable Gymnasium, so that young men and women, when the weather is wet and the days are short, can go to an airy hall and practise Physical Exercises and have other innocent amusements, which are so essential to their general health. But this cannot be done without additional funds, obtained from a much larger Roll of Members. It is therefore hoped that all will help the Health Society, not only with their money but with their interest, and such help will be a great spur to the Committee to continue their labours in promoting the health and happiness of their fellow citizens.

In conclusion, the Committee cannot omit to give their sincere thanks, in the name of the Health Society, to those distinguished gentlemen who have so kindly and so successfully delivered, without thought of remuneration, the lectures during this session. These gentlemen must have the pleasing satisfaction of knowing that they have done much to assist the objects of the Society and to promote the well-being of the community.

SOME LESSONS FROM MODERN MEDICINE.

BY J. A. RUSSELL, M.B., F.R.S.E.

DR J. A. RUSSELL, in treating of "Some Lessons from Modern Medicine," said:—The wonderful progress of the arts and sciences in modern times has often been said and sung, but it is not generally known that in none of them has greater improvement been recently made than in that art which affects us all so closely, because it deals with our very persons. Not only is this the case as regards ground already gained, but at this moment the science of medicine more than any other is rich in promise of benefit to mankind in the near future. That this should fail to arrest attention is not wonderful. The way to attract the admiration of the multitude is to cause human misery, not to cure it; to slay men in thousands. not to save them. Alexander, and not Hippocrates, is called the Great: Napoleon the First, and not the inventor of chloroforming, is the Hero. Moreover, discoveries in medicine often require technical knowledge to understand them, or they apply merely to sick people; or, what appeals still less to the imagination in healthy persons, they merely show how to ward off disease from those who feel no present ill.

There are indeed those who deny that any discoveries are made, or any progress gained. These are persons who do not believe in science, but believe in themselves, and who usually unite extreme credulity to scepticism. Because medical art cannot meet all demands upon it, and honestly acknowledges the fact, they dub the science conjectural, and, refusing credence to whatever is demonstrable, plain, and reasonable, put the blindest faith in whatever is mysterious and unknown. Such was Madame de Sévigné, who, never wearied of uttering sarcasms on the inanity of medicine, at the same time inundated her friends with a mass of absurd remedies; and many now resemble her in this who want her wit.

Putting aside for the present the gains by sanitary science, and advances in the principles of medicine, let us call before us a single advance in the details. Twenty years ago the operation of ovariotomy could only be attempted at the risk of a criminal prosecution for performing an operation so dangerous as to be unjustifiable. Patients suffering from the disease which this operation cures had then the prospect of inevitable death in about two years. To-day it is one of the safest operations known to medical art, and one surgeon is able to boast that he has added upwards of ten thousand years to the sum of the lives of his patients.

If we ask how the knowledge of these bounteous gifts of medical science to civilised man has been attained, we find that it comes mainly from three sources. We have *firstly* the advance in chemistry and other branches of physical science, and the invention of instruments such as thermometers and microscopes to aid and enlarge the powers of our senses; or of instruments contrived to take direct records of fact, which are independent of the fallacies incident to the use of our own senses.

The discovery of chloroform was due to pure chemical research, though its anæsthetic properties were afterwards ascertained and applied by Sir James Simpson. Let Sir James draw the lesson in his own words:—"It is perhaps not unworthy of remark, that when Soubeiran, Liebig, and Dumas engaged, a few years back, in those inquiries and experiments by which the formation and composition of chloroform was first discovered, their sole and only object was the investigation of a point in philosophical chemistry. They laboured for the pure love and extension of knowledge. They had no idea that the substance to which they called the attention of their chemical brethren could or would be turned to any *practical* purpose, or that it possessed any physiological or therapeutic effects upon the animal economy. I mention this to show, that the *cui bono* argument against philosophical investigations, on the ground that there may be at first no apparent practical benefit to be derived from them, has been amply refuted in this, as it has been in many other instances." Surely no one in this audience who has undergone a surgical operation in blessed unconsciousness, or still less any one who has endured the pain chloroform could defy, will ever again say, "where's the use," or cast ridicule on those who strive to add to our scientific knowledge without having an immediate practical end in view.

Not only do we now possess an array of drugs unknown forty years ago, which put additional powers within our reach; but the intimate action of the old drugs, whether upon muscle or nerve, heart or brain, has been so elucidated that they are used in quite a new way, and so promising is the outlook that Professor Huxley says, "It will, in short, become possible to introduce into the economy a molecular mechanism which, like a very cunningly contrived torpedo, shall find its way to some particular group of living elements, and cause an explosion among them, leaving the rest untouched." I fear that this desirable torpedo will not be discovered in Edinburgh, for the Secretary of State has recently refused a license to our Professor of Materia Medica to perform a few experiments on frogs and rabbits with a drug from Borneo where it is used to anoint the arrows of the natives. The operation for which leave was refused is identical with that performed by nurses every day, when medicines are administered subcutaneously with the aid of a syringe and hollow needle. For aught we know this drug may possess some property that would relieve some one near and dear to us from suffering and sickness, and save us from anxiety and grief; but the man, whom we in Edinburgh have set apart as specially competent to make enquiry for us, is arrested through the action of a small body of zealots, who insist that their zeal, though not according to knowledge, shall be testified in *our* unabated pains and recorded in *our* losses.

The invention of instruments for observation has had much to do with alterations in medical treatment, by giving such clear indications, that the physician can avoid doing wrong, even if he does not know how to do right. As an example of change of practice, I may mention that in the year 1833 one of the London Hospitals used 48,900 leeches, while last year it used only 250.

Statistics.—The second source of medical knowledge that I would mention is Statistics, which are now applied to the investigation of innumerable problems and have been fruitful of important information in the most unexpected quarters. They render great service in testing opinions. Opinions differ from facts in that they lie in the nebulous region between the known and the unknown. They form too unstable a foundation for the erection of any weighty system of practice, but when tested and found to rest on the firm rock of fact another step forward can be taken.

Twenty years ago no one knew of the association between pulmonary consumption and a damp subsoil, but statistics have fully proved the connection. In fifteen English towns recorded by Mr Simon the deaths from consumption fell immediately when the subsoil was dried by a system of drainage. In Salisbury the deaths from consumption fell 49 per cent.; in Ely, 47 per cent.; and Merthyr Tydvil, which gained least, had its death rate from consumption lowered by 11 per cent. By statistics we were pointed to the high mortality from consumption in the British army, and especially in the Guards, due to confined air—a mortality which has been so affected by better ventilation of barracks that the consumptive death rate fell in the Guards from 125 in 10,000 in the year 1858 to 16·9 in the year 1875, that is to say, the deaths from consumption alone in the Guards in 1875 were less than a seventh of the number in 1858. By statistics we learn that drapers die at a rate of 108, compared with 76 of grocers, and we also learn that this excess of deaths, in a class of men who live as a rule under similar social conditions to the grocers, is due to asthma and other pulmonary complaints and are thereby pointed to the cause in close, ill-ventilated shops, having an atmosphere laden with fluff and dust, and windows and doors blocked with goods. The grocer, on the other hand, owes his favourable position on the scale of mortality to an active trade carried on in an open, well ventilated shop, with the door usually wide open. By this same method we can trace the effect of each different trade and profession upon health and longevity, and are brought to face such questions as, why hairdressers should have a mortality half as great again as that of the agricultural labourer, or why publicans should die almost as rapidly as cabmen, and at just twice the rate of the clergy. The answers to such questions deserve our careful study, for they point out the direction in which improvement is required, and whether the reform is of that small class which can be accomplished by the summary method of legislation, or whether it requires a change in social habits, or alterations in the conditions of living and working. We can not only compare one trade with another, but can discover the influence of race and its associated customs in the exceptional longevity of the Jews all over the country. The influence of social customs among ourselves can be examined in the same way, and when we find that total abstainers live longer than other classes of the community, we are prepared to believe that they are self-selected—in part at least—by their native vigour of constitution, and that they can eat more and probably work more than non-abstainers.

We may almost say that through statistics we can prophesy the future, for such is the regularity of nature, and so unvarying are her operations under similar conditions, that though nothing is more uncertain than the time of death of any single individual, yet nothing is less liable to vary than the age at which each thousand of 100,000 children born in any year will have passed away, and so much do varying circumstances tend to balance each other, that the number of accidents on the London streets may be very closely predicted for any day.

This is what renders LIFE ASSURANCE possible, and has done so much for the promotion of thrift, and social improvement of the middle classes of society. The same boon is now offered to the wage earning classes through the post-office and assurance companies, with schemes for insuring against death or sickness specially adapted to their circumstances.

In the prospectus of a new company—the Scottish Life Assurance Company, Limited—which has instituted a thrift department as a specialty, I see that at age twenty-one £100 with profits may be insured for 3s. 4d. per month, or £50 with profits for 1s. 8d., a sum which will not keep the pipe of an ordinary smoker alight for the same period. The practice of life insurance is to be commended for its moral consequences as well as on other grounds. It aids virtue and increases self-respect, by giving the assurance, that not death itself can prevent the discharge of those obligations to our families and society, to which we are in honour bound. It is well then that any doubts respecting the foundations of insurance can be quenched in the cool clear waters of scientific certainty. The intention of insurance being to render us independent of the uncertainty of life and provide a fixed sum at death by contributions to a common fund, it is plain that those who die early contribute least to the fund, and that the long livers are in a sense the financial losers by the arrangement, for they have to make good to the fund the sum beyond their contributions carried off by those who die before they attain the average age for which the premium is calculated. If each person could foretell the time of his death there would be no insurance, for the long-lived would refuse to join purses with the short lived; and even now, stringent precautions are taken to exclude this class, who will find it increasingly difficult to get insured, as medical science advances, and is more and more able to predict the future.

Preventive Medicine.—Let us now turn to the statistics, without which preventive medicine could not exist, and let us see what this branch of medicine, which teaches that it is easier to *keep* out of illness than to *get* out of it, has been able to do for the health of the country.

We find in the Registrar General's returns for England and Wales that the death-rate for—

1841-51 was 22·33.
1851-61 „ 22·25.
1861-71 was 22·50.
1871-81 „ 21·27.

So that here is a very marked fall in the last ten years. From these figures, it is seen that during the thirty years from 1841 to 1871, the death-rate did not increase, though all over the country a rapid change in the distribution of the population was taking place—a change, the natural consequence of which is greatly to increase the death-rate. The country population is nearly stationary in number; while the rapid growth is altogether in urban districts. In Scotland, during the last ten years, the larger towns increased 37·37 per cent. in population; while the Mainland rural districts only increased 2·81 per cent.; and the population of the

Insular rural—the healthiest districts of all—actually diminished in number by 1·3 per cent.

In England and Wales it is not so easy to define what is town and what is country; but, at the late census, the proportion of persons living in places which, for one reason or another, were considered to be of sufficient importance to exercise urban powers, to persons living elsewhere was 212 to 100; or, if we reckon as rural all places with populations under 3000, the proportion of dwellers in towns is 66·6, and in country 33·4, and on this basis the estimate of town population would be in 1861, 165 dwellers in town, to 100 in country. At the census of 1871, the number had risen to 184, and in 1881 had reached 199; so that this year, the number of dwellers in towns is almost exactly double the number of dwellers in the country.

Now, if there is one fact more than another which the Registrars-General, both in England and Scotland, delight to din into our ears, and to illustrate and prove in every report, it is that, just as the density of the population increases so does the death-rate—that, in fact, the nearer people live to each other, the shorter their lives are. They show that where the density is 166 persons to the square mile, the death-rate is 17 per thousand, where it is 1,718, the death-rate is 25, and where the population is 12,357 per square mile, the death-rate is 38 per thousand. The Registrars-General are so impressed with this fact that they delight to turn it over and present it to us in all kinds of different aspects. Sometimes they arrange us by the acre, as you would see in Dr Smart's lecture last year on Preventible Diseases. Sometimes they imagine us spread separately over the ground, and they measure our distance from each other in each district, and call it our proximity in yards, but always with an unvarying result—a higher death-rate accompanies proximity to each other, and the nearer to each other in yards we are, or the more of us there are upon an acre, the higher the death-rate. Thus it is shown that in 53 districts, where the proximity is 147 yards, the mean duration of life is 51 years. In 345 districts, where the proximity is 39 yards, the mean duration of life is 45 years. In 137 districts, where the proximity is 97 yards, the mean duration of life is 40 years. In 47 districts, where the proximity is

46 yards, the mean duration of life is 35 years. In the Manchester district, where the proximity is 17 yards, the mean duration of life is only 29 years. And in Liverpool, where the proximity is 7 yards, the mean duration of life is only 26 years. Has then sanitary science accomplished nothing between 1841 and 1871, when, in the face of such a law and the growing aggregation of people into towns, it has prevented the death-rate from rising?

It has done more than this, for if we examine the statistics of the last decade, 1871-81, when sanitary measures have begun to bear fruit, we find that the death-rate has fallen about 4½ per cent. in England and Wales, viz., from 22·5 to 21·27; while the lower death-rate of this decade, says the Registrar-General, "implies the survival of 299,385 persons, who, with the previous rate of mortality, would have died." A report states that—"if twelve cases of serious, but non-fatal illness, be reckoned for every death, it follows that about three million persons, or over *one ninth* of the whole population have been saved from a sick bed by some influences at work in the past decade, which had not been in operation previously." Of this reduction, which is "only an instalment of sanitary progress," more than three quarters is due to a fall in the deaths by the seven zymotic diseases, from 4·14 per cent. to 3·36 per cent. Those diseases "are the most influenced by sanitary improvements, and the most easily controlled by sanitary authorities." "And of this three quarters, just half or three eighths of the entire reduction is in fever—the disease which, more than any other, shows itself in connection with such faults of drainage, of water supply, and of filth accumulation, as it is within the province of good sanitary administration to remove. The fever death-rate has fallen steadily from 80 per 10,000 in 1870 to 32 in 1880.

EDINBURGH. — Looking nearer home, I find from a table kindly given me by Dr Littlejohn, that if the ten years, 1870 to 1879, be divided into two periods of five years, there is a fall in the death-rate from 22·88 in the first quinquennium to 20·82 in the second, and that the whole of this gain is due to a fall in the zymotic rate from 4·59 to 2·43. This, though a gratifying tribute to the usefulness of our Health Department, shows that the conditions which produce our mortality otherwise are not affected, and a death-rate even of 21 per thousand in a city like Edinburgh, not crowded by a poor industrial population, challenges the serious consideration of her citizens. The Registrar-General in his last detailed report gives our mean annual mortality as higher than that of Aberdeen, Leith, or Perth, and it becomes us therefore to inquire, what can be done to counteract the operation of the law of density. That the inhabitants do not much fear the operation of this law, is to be inferred from the stipulations as to new streets and buildings, inserted by them in their local Police Act of 1879. While in London no street may be less than forty feet wide, exclusive of any gardens, open areas, fore-courts, or other spaces in front of the houses; in Edinburgh the minimum width of a new street is only twenty feet, and moreover the width is to be measured from the houses or buildings. In London the height of a house must not exceed the width of the street. In Edinburgh the house may be once and one-half times as high as the width of the street. With such regulations as it possesses, and the very great number of public commons surrounding it, London may continue to grow in size, but not in density of population, and will continue to be the healthiest large city in the world. The contrast between Edinburgh and London in these respects seems fitted to excite some anxiety for our future, and may well call for such interest in the public health, on the part of the citizens, as shall influence municipal action. In health, as in other matters, the citizens must look to their own interests, and they cannot expect that the Medical Officer and Health Committee either will, or can, march on in advance unsupported by public opinion. Those in an official position, unless supported by the public, will always feel weak when enforcing health acts upon persons whose self-interest is opposed to healthy surroundings for others.

But some one will ask, in what way does density kill us? and I answer, mainly by inducing three great causes of preventible mortality:—*First,* ZYMOTIC DISEASES, which smite chiefly the juvenile population from birth to puberty, and are as a class associated with filth. *Second,* PULMONARY COMPLAINTS, such as consumption that chiefly prey upon early adult life, and are largely associated with confined air. And *Third*, DISEASES OF THE ORGANS of the body which mostly attack those in middle age, and are associated with intemperance.

Then, can the action of this law of density be suspended or modified? Not in ordinary conditions; but exceptional discipline, unlimited wealth, and energetic sanitary action can modify the law. The true cure for the law is that given by Dr Farr, who says—"It is certain the most effective means of reducing mortality is to thin the dwellings of the denser parts of the population, to abolish all rookeries, and not to rebuild them." In prisons the death-rate is low, very low, but there discipline is paramount. In the Peabody Model Lodging-houses, London, the death-rate is alleged to be only 16·7 per thousand for the last 16 years, while that of crowded neighbouring districts is 30 to 40; but the class who inhabit them is higher in the social scale than was intended, and the trustees began with half-a-million sterling, and now have £720,000. The effect of energetic sanitary action is seen in the reduction of the Glasgow death-rate to a point, still high, but far below that fixed by the law of density. The credit of this improvement is greatly due to the Hon. Lord-Provost Ure, who, aided by a distinguished medical philosopher, as adviser, has saved more lives than any other man in Scotland.

If we are to depend solely upon sanitary action to countervail the operation of the law of density, we shall be like a ship that puts to sea with a leak, and whose safety depends upon unremitting pumping. And who are those chiefly interested in keeping the pumps going? Undoubtedly those struggling to maintain a respectable and honest independence, to whom the loss of time and means which is involved by illness, or by having to support broken-down neighbours by rates or charity, threatens a breakdown for themselves, and loss of their position and self-respect. This class, then, so helpless individually, should pay special attention to the way in which their health is treated by the Local Authority.

I shall be told that if I attack density I trench upon the rights of property. Now, I would be most careful of rights of property. There is no property to which a man has a better right than to his own health; and wherever alterations or operations are proposed, that would infringe upon this, which is every man's property and the poor man's sole capital, is it not fitting that these alterations should be controlled by sanitary legislation? The rights of property of some men when examined turn out to be wrongs to the property of others. It seems fair in most cases that landlords' existing rights of property in towns should only be touched by improvement schemes that give compensation. But has any man a right *of new* to crowd buildings upon the ground to such an extent as to shut out light and air, and give him double feu-duty, at the expense of the health of the residents? Is not the additional feu-duty that is derived from buildings erected in addition to those allowed by Sanitary Science, so much money taken out of the pockets of the community, and an injury to the property of others? Am I not injured, if, to give excessive feu-duty to a landlord, my neighbour is so crowded as to fall sick? Am I not injured when I am deprived of his services? Am I not injured when I support him in the Infirmary? Am I not injured when I support him in the Poorhouse? Am I not injured when I support his sons in Reformatories and Prisons? And am I not injured when his daughters, instead of being a source of purity and strength to the community, become a cause of weakness and decay? Let us have the allowable density of buildings fixed by enactment at a standard compatible with health, and then a "fair rent" is found by competition.

COMPENSATION.—But is compensation not required and due? I say, wherever it is due, by all means let it be paid; but first make sure by whom it is due. To illustrate this, I shall quote from a paper by Dr. Russell of Glasgow upon a case where compensation was demanded, consequent upon alterations ordered by the sheriff to correspondingly improve the ventilation of a building, in which the population had been trebled by subdividing it into single-room dwellings. These alterations spoiled six apartments renting altogether at £27. Dr Russell says:—

"Much emphasis was laid by the respondent upon the fact that the destruction of those six single apartments was a loss of rental amounting to £27 per annum, the houses being let at £4, 10s. each. This was designated an unwarrantable "confiscation of property," and "compensation" was insisted upon. It was asserted by architects that the consequent improvement on the property fully balanced this apparent loss, and that it must even be recompensed by a larger rental for healthier houses. But, let us take the loss of £27 per annum as an absolute loss, what is this in view of the enormous death-rate and propagation of sickness, evidently begotten of conditions which the sacrifice of this sum is intended to remove or mitigate? This mortality and accompanying loss of health and working-time on the part of the adult working population, prevailing through a period of years, represents a sum of money taken out of the pockets of householders and of rate-payers, and for whose sole advantage? If there is to be any discussion of 'compensation,' it must evidently be in the way of compensating the public." "The rental of those houses, let in excess of the number consistent with conditions of public health and safety, ought to be a charge against the property on the principle of higher premium of insurance required against a hazardous risk." But I shall be told, those houses were taxed upon their rental for sanitary purposes, and therefore contributed their fair share to the expenditure of the community on this behalf. Let us take the rental of these thirty-nine single apartments at £5 a-piece and of these six double apartments at £8. This gives an assessable rental of £243, say £240. Being under £10 in each case, the assessment for sanitary purposes amounts to 20s. at 1d. per pound, and for hospitals under the Public Health Act, to the large sum of half-a-crown, at one-eighth of a penny per pound. This is a contribution of £1, 2s. 6d. per annum or £9 in the eight years. Of that not a penny is paid by the owner. During that time twenty-three cases of infectious disease were removed to the sanitary hospitals, and treated at the public expense. For keep, treatment, and share of rent-charges, up-keep of buildings, &c., &c., £5 is a moderate estimate of the cost of each of these cases. This amounts to £115 for this item alone! Besides, there is the expenditure for maintaining a staff of men to form a cordon of inspection and observation from day to day around such properties. It would be well that the ratepayers should remember those figures in the face of demands for 'compensation' and *ad miseri-*

cordiam appeals made by the respondents in this and similar cases. The fact is that every such property is a sort of running sore upon the body of the community, diverting its substance from healthy uses, and draining the life-blood of the public. There is scarcely a fraction of the sanitary assessment drawn from the west end of Glasgow, or the shops in Buchanan Street, expended directly upon the west end or in Buchanan Street. It is spent upon the miserable properties which are the plague spots of the city, in a vain endeavour to keep down their disease and death-producing effects, the owners meanwhile pocketing the rents nett, so far as sanitary assessment is concerned, and crying out, 'confiscation,' 'compensation,' the moment an attempt is made to reduce this expenditure by operating upon its causes."

Rent.—Apart from political pressure, private individuals can do something to exempt themselves from the law of density. They can take the best house their means will afford. And here I earnestly commend the Glasgow health lecture, "The House," for its practical advice, and its clear statement of the moral and physical consequences of deficient house room. Workmen have often complained to me of the high rents and comparatively small number of houses suited for working men in Edinburgh. They complain that the rent of a large house may be only 4 per cent. upon its value, and yet 10 per cent. upon value may be charged for low-class property. But what is the reason of this? Is it not the difficulty and trouble of collecting small rents, the risk that some of them may not be forthcoming or of moonlight flittings, and the tremendous dilapidation caused by reckless tenants? Is it not the case that the wealthy tenant causes little damage, and will often repair it himself rather than trouble his landlord, while the rough and ignorant poor tenants smash and spoil and choke whatever can be injured? If the erection of workmen's houses paid even 5 per cent. without trouble, would there not be a rush of capital to build them? This is just an instance of the good being punished by high rents for the faults of the bad. The only way in which the working classes can have cheap houses seems to be for them generally to do as many of them have already done, and buy their houses for themselves. With the aid of the investment companies, in which Edinburgh abounds, this can be accom plished. All that these companies require is that the applicant shall produce such a sum as may prove that he is in earnest, and secure them from loss. Of course, where boys marry at twenty-one, or earlier, as soon as they have escaped from their apprenticeship, it cannot be expected that they can do anything of this kind. But I fail to see why they need marry until they prove their respect for their intended wives and their intention not to depend upon charity in every little calamity, by doing something towards providing a home.

Opposition.—Ere passing on from the head of Vital Statistics, we may profitably ask how they were received when first introduced. The first bill for taking a census was introduced into Parliament in 1753, but defeated by such language as the following :—Mr Thornton, member for the city of York, said—"I did not believe that there was any set of men, or indeed any individual of the human species, so presumptuous and so abandoned as to make the proposal we have just heard." And Mr Matthew Ridley, member for Newcastle-on-Tyne, said—"The people looked upon the proposal as ominous and feared lest some public misfortune or an epidemical distemper should follow the numbering." These gentlemen belonged to a class which is active at the present day, and which although opposed to progress, has advanced so far as to form a number of Societies recognisable by the prefix Anti to their names—as Anti-vaccination, Anti-vivisection. The members of the sect of Anti-..s are eminently respectable; many of them are philanthropic and pious ; all of them are unreasonable and opposed to progress. The sect has always shown a remarkable tendency to wrest Scripture. Their formula, which they apply to every advance in knowledge, is this—First, It is not true ; Secondly, It is contrary to religion ; and, thirdly, It is not new, or we knew it all before. Such a venerable sect deserves a history, but time will only permit me to go back to the year 1600, when we find the sect embracing several cardinals, and in such high power that, through the Inquisition, it pronounced sentence upon Galileo, the astronomer and inventor of the telescope. Part of the sentence runs as follows :—"To maintain that the sun is placed immovable in the centre of the world, is an opinion absurd in itself, false in philosophy and formally heretical, because it is expressly contrary to the Scriptures; to maintain that the earth is not placed in the centre of the world, that it is not immovable, and that it has even a daily motion of rotation, is also an absurd proposition, false in philosophy, and at least erroneous in point of faith," It will be instructive just now to consider the terms of Galileo's reply to this, in his letter to the Grand Duchess of Tuscany. He says: — "I am inclined to believe that the intention of the sacred Scriptures is to give mankind the information necessary for their salvation, and which, surpassing all human knowledge, can by no other means be accredited than by the mouth of the Holy Spirit. But I do not hold it necessary to believe that the same God who has endowed us with senses, with speech, and with intellect, intended that we should neglect the use of these, and seek by other means for knowledge which they are sufficient to procure us; especially in a science like astronomy, of which so little notice is taken in the Scriptures that none of the planets, except the sun and moon, and once or twice only Venus, under the name of Lucifer, are so much as named there. This, therefore, being granted, I think that in the discussion of natural problems we ought not to begin at the authority of texts of Scripture, but at sensible experiments and necessary demonstrations; for from the Divine word sacred Scripture and nature did both alike proceed, and I conceive that, concerning natural effects, that which either sensible experience sets before our eyes, or necessary demonstrations prove unto us, ought not upon any account to be called in question, much less condemned upon the testimony of Scripture texts, which may under their words couch senses seemingly contrary thereto."

The sect of Anti-. . . s has attacked every step forward in physical science; but its choicest comminations have always been devoted to improvements in medicine. Of course such a venerable and respectable sect included some doctors, so that many of the attacks have come from within the profession. Before the method of tying vessels with ligatures was invented, the only method in use for arresting bleeding in amputations was the barbarous one of searing the stump with a red-hot iron, or of plunging the limb into boiling pitch. When Paré introduced his method of tying bleeding vessels with ligatures it was received with the bitterest abuse. From that time the next important appearance of the sect was made in connection with the introduction of the practice of vaccination. An anti-vaccine society was forthwith formed to protest against "a gross violation of religion, morality, law, and humanity." "The projects of these vaccinators," it was said, "seem to bid bold defiance to heaven itself—even to the will of God."

Sir James Simpson said—"Every proposed improvement seems to be met with the same invariable array of objections and arguments. The discovery may be new, but the grounds of opposition to it are not new, they are merely the old forms of doubt and difficulty and prejudice used on former occasions recalled and reproduced anew." This sect came to the front more at the time of the invention and application of chloroform and of anæsthetics generally than at any other time. Within the medical profession itself many men were exercised about the abolition of pain, and putting patients to sleep. The clergy became involved in the contest, from bishops downwards, and especially when Sir James Simpson proposed the use of chloroform in midwifery; and objections were so many and so varied that I verily believe Sir James Simpson showed more cleverness in combating the Scriptural and other objections than he did in introducing chloroform. Take a characteristic example. Dr P. of Liverpool said:—"I became increasingly aware that I must trench upon what might really appear to be exclusively the province of the Divine, but in which, nevertheless, in our own professional standing, and in the standing of baptized men, as opposed to heathens, we must assuredly have our place, and that a most important one." "What right have we, even as men, to say to our brother man, 'sacrifice thy manhood, let go thy hold upon that noble capacity of thought and reason, with which thy God hath endowed thee and become a trembling coward before the presence of mere bodily pain. What right still less have we as baptised men—men having a Redeemer, and gifted with the Holy Spirit to be our Comforter—what right have we, ungratefully or unbelievingly, to forget all this and be willing to go under the deep stupor of a power, the influences of which and connected with which, we know so exceedingly little?" It is perhaps not wonderful that he should go wrong in his theology; but when he comes to medicine he is just as bad. He says:—"Besides, we have as yet no time to watch *other* consequences; but one, I fear, in particular will become more common—I mean insanity; I wish I may be mistaken, but I greatly fear it." The same people who, in the early days of the application of anæsthetics in midwifery, insisted upon the "propriety" and the "desirability" of pain, and who demanded that the accoucheur should take upon himself the function of executioner of the curse denounced in Genesis chap. iii. ver. 16, "in sorrow thou shalt bring forth children," now-a-days revile and decry any one who endeavours to learn how to save men and women from suffering by inflicting the most trivial pain upon a frog.

Experiments.—The *third* great cause of advancement of medicine to which I intend to allude is experiments upon animals. These are either made on a large commercial scale upon men, or on a very small scale for precise scientific ends upon the lower animals. Since 1873 sixty-seven grave experiments of the former kind were made upon the population with infected milk; that, in fact, putting on one side commercial experiments with water, with infected clothing, and with infected dwellings, we had sixty-seven epidemics from infected milk alone. In the commercial experiments with typhoid fever poison in milk, 3500 persons were involved, and in the commercial experiments with scarlet fever poison 800 persons were involved, and in diphtheria poison 500. In the fifty epidemics of typhoid, twenty-two were due to "washing the cans," or what milkmen call washing the cans, with foul water. The year 1873 is not so far back, and we need not find it difficult to appreciate these figures. It is important that you should be aware that the means of controlling these fevers are at the present day crowding upon us through experiments upon animals, especially through the experiments of a distinguished Frenchman, Monsieur Pasteur, who has added enormously to our knowledge and to our resources. He has been able to cultivate out of the body the poisons which cause certain diseases, and he has shown that in one of the fevers which we call splenic fever, and which affects man and animals alike, the poison is a vegetable of a very low form of organization. Dalton, the chemist and inventor of the

Atomic Theory, said he could never think of the atoms without thinking of them as penny pieces. In the same way we may think of these organisms as beans with stalk and seed, and this will help us to realise that the effect of these organisms, and the development of the disease depend partly upon whether we have been infected by the plant or by the seed. This explains, also, how it is that sometimes the infecting power is fugitive, while at other times it puzzles us with its long-continued infective properties. The plant is very easily killed, but the seed is very enduring and possesses great vitality. Cold will kill a plant, but cold will not kill a seed.

Pasteur has also investigated a disease called Fowl-cholera. It has nothing whatever to do with cholera, and only resembles it in that it kills fowls very rapidly. He has discovered that this disease is due to a low organism, which can be cultivated, and grows very rapidly in chicken soup. He took a vessel of chicken soup, and dropped into it a drop of infected blood about the size of a pin's head, and he found that it soon infected the whole bowl. Presently a change took place in the soup, the organism could be seen under the microscope, and the infected chicken soup was now a virulent poison for fowls. But not only so, M. Pasteur observed that you can pass on the infection from one bowl of soup to another by merely putting a drop of the infected soup into the new and fresh fluid, and so on to a thousand bowls it might be; and that if you take a drop from the last of them and, having scratched a fowl, inoculated it with the fluid, it will take the disease and die. These experiments were repeated until there could be no doubt as to their accuracy. This is the stage which was reached last year when Dr Smart gave his lecture. But M. Pasteur has gone far beyond that within the last twelve months.

He can now produce a modified splenic fever, or a modified cholera of fowls. That is to say, by a suitable cultivation of these organisms, he can so change the properties of the plants that, when a fowl is inoculated, it shall take the disease in an easy way, and shall not die. But, more than that, the effect of the modified disease is as good as if the fowl had taken the disease in its severe form, so far as preventing its recurrence is concerned. And he has managed in this way to inoculate the fowls with a tamed virus which confers a protective influence and yet ensures that the fowl shall recover. Of his methods of doing this I shall not speak further than to say, that one of the agents which M. Pasteur used in taming the virus is oxygen, and this seems to point to one way in which fresh air may influence the poisons of specific diseases. Indeed, Mons. Pasteur can so tame the organism that it will no longer give rise to any disease at all, and he has discovered where to stop short in the cultivating or taming process, so that he shall get the protective influence of the disease without killing the fowl. This process has been applied by him on a large scale in the treatment of the splenic fever which devastates whole herds of oxen and flocks of sheep on the Continent. In the course of his experiments he inoculated twenty-five sheep with the cultivated virus, and other twenty-five with the virus which had not gone through the cultivating process. The result was that the whole of the twenty-five that were so treated with the uncultivated virus died within fifty hours, whilst of the twenty-five inoculated with the cultivated virus not one died, and yet they were found afterwards to be insusceptible of taking this disease. Whenever this was made public, there was, of course, a rush of the farmers all over France to get their cattle inoculated, and the cattle are now being inoculated in thousands every day. So that here we have a remarkable instance of the experiments on animals benefitting the animals themselves in the first instance. M. Pasteur has followed up these researches with the most admirable ingenuity. Thus he has found that the spores of anthrax may last for over twelve years, and that oxen may take the infection from them through grazing over ground where previously other oxen had been buried, and where the spores of the disease had been brought up to the surface from the depths of the ground by worms. This discovery is rather interesting to English people on account of its association with Mr Darwin's last book, where he showed the curious office that is performed by worms in carrying up deeper portions of the soil to the surface. And here we find the same explanation in France found applicable to the coming up of the poison of diseased animals to the surface to infect the living. Of course, this points out the lesson that the only effectual way of destroying these bodies is by cremation.

I may say that our practical light at present as to the means of preventing the spread of infectious diseases is as follows—*to avoid filth and to isolate disease.* That comprises the whole practice of the matter. How are we to isolate disease? I may be asked. In Edinburgh the Corporation has recently provided a fever hospital for that purpose, but it is most disappointing to find how little interest the public take in such a step forward, and how little they seem to care about it. We have in this hospital at present the means of affording the poorer classes a ready escape from the dangers of treating these infectious diseases at home. An instance recently came under my notice that shows these dangers. One of the children in a family took scarlet fever. The parents were urged to send off the child to the fever hospital for the sake of protecting the other members of the family and other inhabitants of the common stair. They declined to do so, because as they said the other members of the family had had it already, and therefore they supposed there was no danger to their household, and, as for their neighbours, they might take care of themselves. Now, all their neighbours—wonderful to relate—escaped. But another of their own children took the fever a second time very slightly and died of the secondary effects before an ordinary case would have recovered from the fever. I hope we will have this hospital so arranged as not only to afford this protection from danger to the poorer classes, but also so arranged as to give adequate accommodation for all classes of society. I hope to see wards fitted up so that any of the wealthier citizens may have two or three rooms to which they may bring the sick person, and any member of the family who wishes to nurse him. The patient might be treated by their own medical attendant, with the aid of the house surgeon, who is kept by the town, which would also provide skilled nursing. Here we can provide accommodation, which they could use in an emergency; and they would be saved both the expense and the trouble of making arrangements at home, which are the more difficult to make because of their ignorance as to what should be done. Of course, they would be expected to pay something for these privileges, and I have no doubt they will be quite willing to do so.

Then, besides having an hospital to which we can carry off a sick person, we also have in this building room for a reception house and refuge for those who are in danger of taking disease from having been in contact with the sick. When a disease of this sort breaks out in a poor family, the proper mode of action, I conceive, would be to capture the whole family, to put the sick member in the fever ward, and to take the others into the reception house, and to watch them, letting them go to their daily work from that house, until we see that there is no risk of their taking the disease, and until we get their own house thoroughly disinfected. When infectious disease breaks out in the house of a wealthy citizen, what happens? Is it not this, that the whole of the children who have not the disease run for their lives to the nearest friend or to a hotel? That being the case, might it not be well to afford them accommodation suitable to their position in this reception house, for which, of course, they would have to pay? But they would have to pay far less for it than they do in a hotel, where the owner would naturally be very chary of receiving them, and if he did receive them, would make them pay accordingly. Now, that something of this sort is very desirable you will at once recognise, when I tell you that last year upwards of 3000 cases of infectious disease were reported to our medical officer of health. There were very nearly 2000 cases of scarlet fever reported in Edinburgh last year, and our accommodation in the Infirmary is for only 74 cases, unless when the disease breaks out to a very large extent, and the corporation steps in and provides fuller accommodation.

It is, I think, perhaps rather an unfortunate circumstance that the infirmary should have anything to do with our fever-house arrangements. The infirmary is a charitable institution, whilst the fever-house is not. We ask the citizens to come to it not in charity to themselves, but as a charity to the rest of the community. And the expenses of this accommodation they have already met by paying their rates, so that we may look upon it as a kind of insurance society to which every person pays, and which is, therefore, open and available to all. And another reason why I think it is a mistake that the infirmary should have to do with these arrangements is this, that those people—and I hope there are not many of them—who shirk their duty and refuse to subscribe to the funds of the Royal Infirmary, in this way get out of their statutory obligation, for the Legislature throws upon every community the expense of the treatment of infectious diseases. If we all contributed to the funds of the Royal Infirmary, it would not matter very much to us whether the treatment was given by that institution or by the Local Authority. But why should those of us who subscribe to the Royal Infirmary be saddled with the expense of the treatment of infectious disease, which is laid by statute upon the rate-payers in general, and others escape without contributing anything for this purpose? I have been told more than once that some people in Edinburgh subscribed to *build* the Royal Infirmary on the distinct understanding that it would, by receiving fever patients, relieve them from their fever rates; in other words, that they paid some of their rates in advance and called it charity, thereby stealing the credit of giving a subscription. Now, I believe, that this is a slander upon the citizens of Edinburgh, who have amply proved that they are unsurpassed in readiness to contribute to public and charitable objects.

THE HUMAN BODY

By D. J. CUNNINGHAM, M.D., F.R.S.E.

> "What a piece of work is a man! How noble in reason! how infinite in faculties! in form and moving how express and admirable! in action how like an angel! in apprehension how like a god! the beauty of the world! the paragon of animals!"—Hamlet, Act ii., Scene ii.

I fear that it is an utter impossibility for me in the space of an hour and a quarter, and within the limits of a single lecture, to give you even a general sketch of the structure of the Human Body. Of all the subjects chosen for this session's series of Health Lectures, that which has fallen to my lot is the widest. The utmost that I can hope to do is to call your attention to some of the more important and interesting points in our bodily mechanism. I cannot waste a single word upon introductory platitudes.

When we are set to examine a piece of machinery, our first and most natural question is: For what is it adapted? what kind of work has it to perform? Having learned this, we are in a much better position to understand the parts of the machine, and the manner in which they are related. Thus when we know that a watch is for the purpose of recording time by the regular movements of the hands on the dial, we can appreciate in a much more intelligent manner the arrangement of the main-spring, wheels, and balances which produce the revolution of the hands.

Viewing, therefore, the human body in the light of a machine, let us first enquire what kind of work it does, or, in other words, what functions it performs.

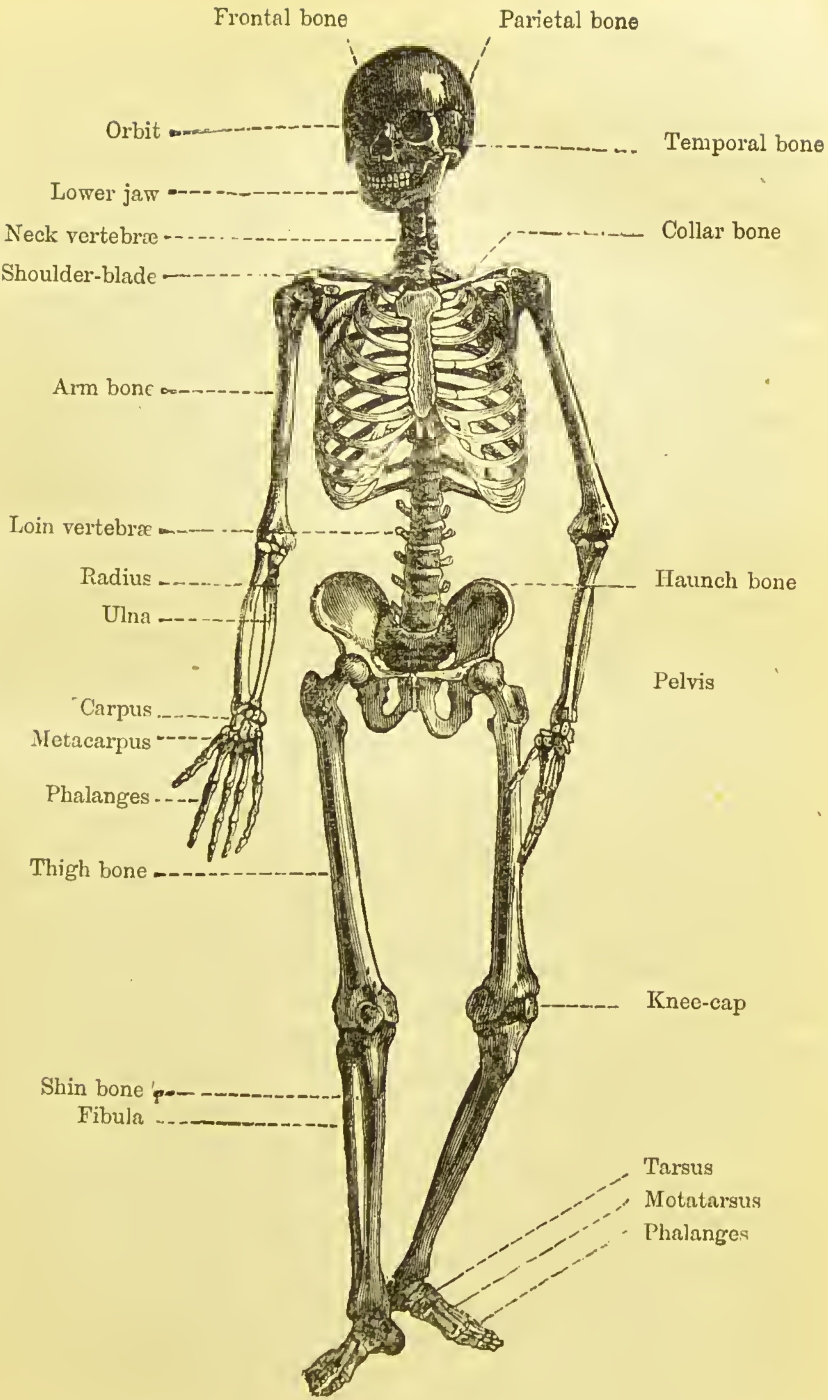
A little reflection will render it apparent to you that we each possess the power of (1) *motion* and *locomotion*; (2) *nutrition*, *i.e.*, we eat, drink, breathe, perspire, &c., &c.; (3) *innervation*, or the faculty by which we are brought into relation with external objects; (4) *reproduction*, or the means by which the race is perpetuated.

If we descend to the very lowest stage of the animal kingdom and examine the *amoeba*—a very low form of life indeed—we find that it is capable of performing, in some degree at least, all these functions. Imagine a minute drop of the white of an egg, and you have in your mind a tolerably exact model of such an animal. It has little or no structure, and yet by contractions of its body it can move about in a liquid medium. Particles of food sink into its substance very much in the same manner as you would push a marble into a mass of putty—any part of its surface serving the purpose of a mouth. In its interior the nutritious parts of the food are extracted and diffused through the mass, whilst the non-nutritious parts are ejected—any point serving the purpose of a vent. Further, this simple organism has some appreciation of external objects; and lastly, it can reproduce its kind by dividing itself into two or more new individuals, each as vigorous as the original.

As we ascend the ladder, the animals we meet lose this simple condition of body. A principle is at work by which the labour the organism has to undergo becomes divided; coincident with this the organism becomes more complicated. By this I mean that each function seizes, as it were, upon a part of the body and adapts it to its own ends. Thus in the higher vertebrate animals we find a skeleton, joints, and muscles subservient to the function of *motion* and *locomotion;* an alimentary canal, glandular apparatus, circulatory system, lungs, and many other parts devoted to the function of *nutrition;* a nervous system for *innervation;* and special parts for *reproduction.*

Man is one of these higher animals, and the pre-eminence which he claims over other animals is in great part due to the superiority of his nervous system—to the more perfect manner in which he is able to carry on the great function of innervation.

SKELETON.—Here we are then; each of us possessed of a body; each of us capable of carrying this body about with us; and each able to move its various parts the one upon the other. Let us


Frontal bone
Parietal bone
Orbit
Temporal bone
Lower jaw
Neck vertebræ
Collar bone
Shoulder-blade
Arm bone
Loin vertebræ
Radius
Haunch bone
Ulna
Pelvis
Carpus
Metacarpus
Phalanges
Thigh bone
Knee-cap
Shin bone
Fibula
Tarsus
Motatarsus
Phalanges

study the means by which this is performed. This leads me, in the first place, to speak of the skeleton.

The skeleton is the bony framework or scaffolding which supports the soft parts of the body. Entering into its composition, there are about 210 separate bones in the adult. In addition to these the framework is completed at various points by plates and bars of cartilage or gristle.

In our study of the skeleton we classify the bones into three great groups, viz. : (1) those belonging to the trunk; (2) those which form the head or skull; and (3) those of the limbs.

The bony scaffolding of the TRUNK consists of (1) the spine or back-bone, (2) the ribs, and (3) the breast-bone.

Spine or Back-bone.—The back-bone is the great central pillar of the body. On its summit is poised the skull; below it transmits the weight of the body to the lower limbs; whilst laterally it bears the bones of the chest, which in turn support the bones of the upper limbs.

In the *child* the spine is composed of thirty-three separate bones, called *vertebræ*, placed one on the top of the other, but as life advances the lower nine segments amalgamate so to form two bones. In the *adult* therefore we find only twenty-six separate pieces entering into the formation of the spine.

If we take any one of these vertebræ we notice that it consists essentially of a solid cylindrical portion, called the *body*, in front, with a bony arch attached to it behind. The two together constitute a ring large enough to admit the first joint of the forefinger. Next look at the vertebrae in position. The bodies are all superimposed the one on the top of the other so as to form a column, whilst the arches also lie in series so as to constitute a canal. In this canal is placed the spinal marrow carefully protected round and round.

The vertebræ are arranged in groups. The first *seven* belong to the *neck*, and it is an interesting fact that in all mammals (with only three exceptions*) the number of neck vertebrae is seven. It matters not whether we examine the lengthy neck of the giraffe, or the short stunted neck of a pig or a whale; it is always seven—neither more nor less.

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* The three-toed sloth, Hoffman's sloth, and the manatee.

The succeeding *twelve* vertebrae bear the ribs and constitute the *dorsal group*, and the *five* following are the *loin vertebræ*. The next *five* vertebrae are welded together into a large triangular bone termed the sacrum, which fits in between the haunch-bones. It is through this bone, therefore, that the weight of the trunk is transmitted to the lower limbs.

It is a popular belief that man has no tail. This is quite a mistake. The sacrum is succeeded by four rudimentary vertebræ usually welded together. These constitute the human tail; but instead of projecting externally, as is customary in the majority of other animals, our caudal appendage is curved forwards in such a manner that we can assume the sitting posture without suffering any inconvenience from it.* The anthropoid apes resemble man in the rudimentary condition of the tail.

But you ask; How are these separate factors of the spine held together? The principal agents in effecting this are a series of tough, elastic, cartilaginous discs interposed between the solid bodies of the vertebræ, and to which the bodies are firmly adherent. They unite the vertebræ in such a manner that whilst the mobility between any two adjacent vertebræ is very slight, the column as a whole possesses great suppleness and flexibility. It can be bent in any direction, and can even be twisted upon itself, as is exemplified every time we look backwards when in the sitting posture.

Have you ever reflected upon what characteristic the high dignity of the body of man depends as compared with that of the lower animals? A little thought will make you see that it is his *erect attitude*. The anthropoid apes, it is true to a certain extent, approach him in this respect, but how shambling, crouching, and half-bent is their gait in comparison with his. The gibbon alone in his progression can dispense with the use of his arms. The chimpanzee, orang, and gorilla when they take to the ground shuffle clumsily along in a semi-erect attitude, using their arms as an aid to their legs. The orang and gorilla have the curious habit of occasionally employing their long arms in the same way as a cripple uses crutches, viz., by placing the knuckles on the ground, and then swinging the body forwards between the arms.

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* Every one has heard the curious story of the "tailed men" of Borneo, who when they wish to sit down have to cut a hole in the ground for the reception of the tail. This story, of course, has always been regarded as a myth, but it is only recently that its origin has been discovered. It has been proved by Mr Bock, in his beautifully illustrated book upon the "Head-hunters of Borneo," that the fable has arisen from the name given to the personal attendants of the Sultan of Passir. They are called "tail-people," which means probably that they follow at the tail of their master (?)

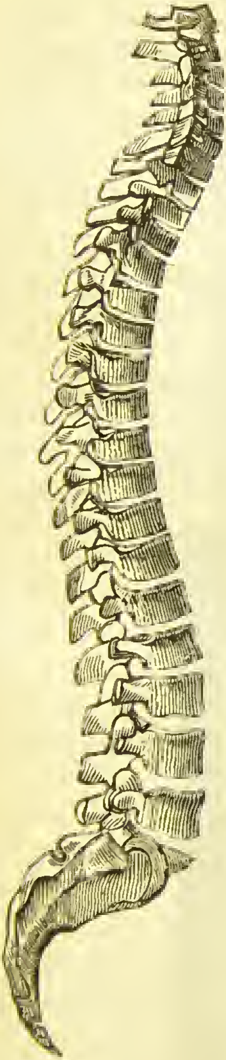
Fig. 1.
Human Spine.

Man alone has attained the perfectly upright posture, and moves freely without the use of his arms; perhaps, however, his tendency to use a walking-stick may be looked upon as a vestige of his former habits!

This important characteristic of man—this erect attitude—is produced by certain graceful and permanent curves in the spine. In the neck the vertebræ bulge forwards; in the back they curve backwards; in the loins they form a convexity forwards; whilst the sacral and tail vertebræ show a convexity backwards. In the man-like apes there is no curve formed by the loin-vertebræ; indeed the only well marked curvature in the spine is that of the sacral and caudal vertebræ. Would it shock those of you who are mothers if I told you that your infants at first present the same characteristics of spine. I mention this not for the purpose of insinuating any relationship between them and the apes, but for the purpose of impressing upon all mothers and nurses the necessity of keeping infants at first as much as possible in the horizontal position, until in fact the child gains strength sufficient to enable it to make efforts at raising itself. The spine then begins to assume those curves so characteristic of man, and so essential to a graceful and dignified bearing.

I cannot pass from this subject without pointing out how beautifully the spine is adapted to prevent jars or shocks to the body. The soft cartilaginous discs between the vertebræ act as cushions or buffers, whilst the curves give a springyness to the column similar to that of a spiral spring.

Chest.—This is the cavity which contains the heart and lungs. Behind, it is bounded by the backbone, viz., that portion of it which is formed by the dorsal vertebræ ; in front, by the breast-bone ; and upon either side by the ribs.

The *breast-bone* is a flat elongated bone which tapers somewhat from above downwards, and which the ancients considered to resemble, in some respects, a sword.

The *ribs* are twelve in number on either side in both sexes. I say in *both sexes*, because I know that the idea is not at all uncommon amongst those unversed in anatomy, that in the male skeleton there is a rib wanting, and that woman is the representative of this missing rib. But this is a popular error. The rib which was abstracted from Adam for the manufacture of Evė has

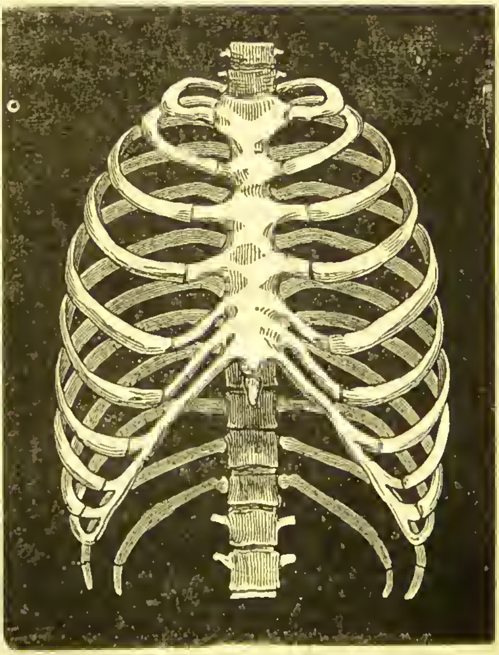

Fig. 2.

Shape of the normal chest.

reappeared in his male descendants. Man, therefore, has been no loser by the transaction, but has recovered his own with usury.

These twelve ribs are attached behind to the sides of the dorsal vertebræ; from the spine they arch forward towards the breast-bone, and as they approach its margin they cease to be bony and become cartilaginous. Only the upper seven of these partly bony and partly cartilaginous arches are directly connected to the side of the breast-bone. The succeeding three are fixed in front to the lower border of the seventh, whilst the two last are quite free in front, and are consequently called the *floating* ribs.

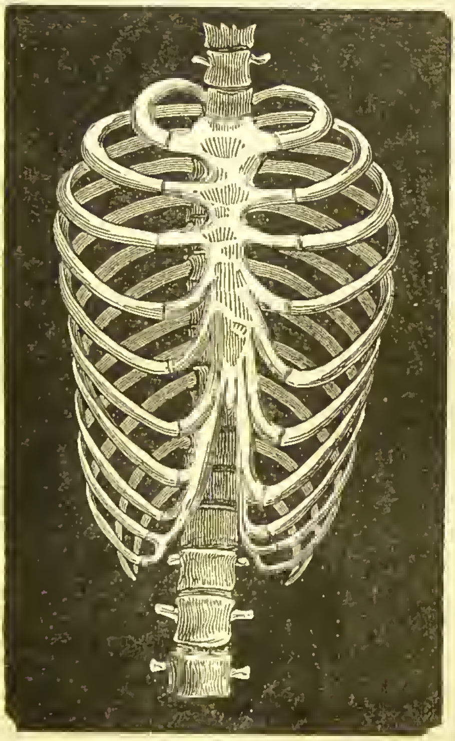

Fig. 3.

Chest of a girl, twenty-three years of age, deformed by tight-lacing. [From Rüdinger's work on Human Anatomy. Contrast this with Fig. 2

This combination of bone and cartilage in the construction of the walls of the chest gives it great elasticity, and contributes very materially to its strength and its capability of sustaining heavy blows without injury.

Let us now examine the shape of the chest-cavity. The chest is a barrel-shaped cavity distinctly conical in form; above it is narrow, but it gradually widens out, so that below it attains a very considerable width.

Such is the shape which nature has given the chest, but in modern civilized countries women endeavour to improve upon nature by the use of stays or corsets. This dressmaker's block shows what the conventional idea of a beautiful female figure is, and *nolens volens* nature must be moulded after this pattern. Compare this block with the magnificent outline of the Venus of Milo*—this fine copy of which I am able to show you through the kindness of Sir John Steell. Observe the difference. By all anatomists this statue is considered the very type of female grace and beauty, and for this simple reason, that it represents truthfully the natural female form in its highest perfection.

But so utterly depraved is the popular taste in this respect that I feel I must give more practical and more cogent reasons why stays should be abolished as articles of dress; and I confess I am ambitious of working some reformation in modern dressmaking. These diagrams show the structural deformity of the chest which tight-lacing produces. The chest is no longer conical (*i.e.*, narrow above and wide below), but it has assumed the shape of the stays and is shaped like an egg with the large end uppermost (Fig. 3, p. 29). Lateral curvature of the spine to a greater or less extent is a very frequent accompaniment of this, and the right shoulder is generally rendered higher than the left.

To understand the full enormity of this deforming practice we must examine the effect it has upon internal organs. Stretching across the lower end of the chest-cavity is a thin muscular partition which separates it from the cavity of the abdomen. This partition is called the *midriff* or diaphragm. It is dome-shaped, forming a highly convex floor for the chest and a vaulted roof for the abdomen. Within the chest, as I have already said, are the heart and lungs. These are accurately adapted to the upper surface of this partition. Moulded to the under surface of the diaphragm is the liver—the bulk of which, however, lies upon the right side of the body. Towards the left side both the spleen and stomach are also in contact with the under surface of the diaphragm. Now the distortion produced by tight stays has mainly two evil effects—(1) it dislodges these organs from their natural position, and (2) it restricts the breathing power. The liver suffers most. Its surface is sometimes deeply indented by the ribs*—sometimes indeed it is driven downwards so as to leave, in

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* Prof. Flower in his little volume entitled "Fashion in deformity" places with marked effect two woodcuts, side by side, viz., an outline figure of the Venus of Milo and a lady dressed according to the present Parisian fashion. A still greater contrast is obtained by placing a dressmaker's block by the side of the statue.

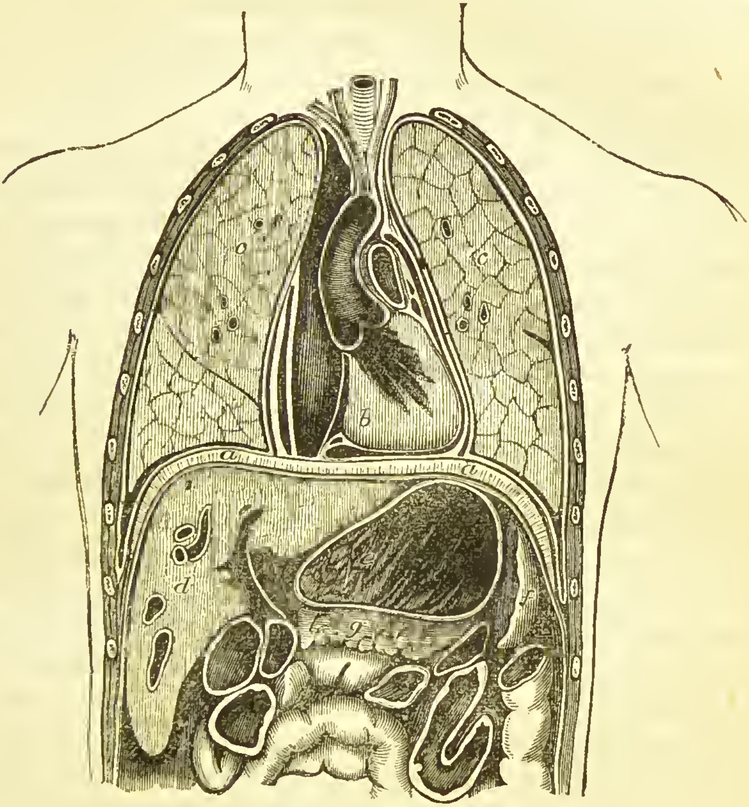

Fig. 4.

Section through the chest and abdomen. (*a*) diaphragm; (*c. c.*) lungs; (*b*) heart; (*d*) liver (*e*) stomach; (*f*) spleen. (Modified from Luschka's Anatomy by Prof. Cleland).

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* It is right to state, however, that Prof. Turner looks upon such furrows as congenital, and produced by certain of the ribs lying upon a deeper plane than the others. He has seen the indentations "almost as frequently in men as in women."

great part, the shelter of the ribs. It has even been found so low in the abdominal cavity as to be resting upon the haunch-bone. The stomach also is compressed and prevented from expanding sufficiently during and after meals. How then can digestion be properly executed when two such important accessories to the process are treated in this cruel fashion ?

But I have said that tight-lacing restricts the breathing power. The act of breathing is produced by the alternate increase and diminution of the capacity of the chest. This is effected by (1) movements of the chest walls, and (2) by the alternate descent and rise of its floor, *i.e.*, the diaphragm. But the walls of the chest when encased in tight stays are bound down so firmly that they can hardly move, and consequently the diaphragm has to do all the work. Now this is the very form of breathing for which women, as compared with men, are worst fitted, and which under certain conditions becomes next to impossible.* The lungs also are so compressed that the blood and air cannot pass freely into them, and the result is that the blood is imperfectly aerated.

We boast greatly of our high civilisation ; we are appalled when we hear that it is the custom of certain barbarous tribes to compress, by means of bandages, the heads of their children so as to give them the shape of a sugar-loaf. I would simply ask you, are we one whit better when we systematically distort our chests ? My belief is that we are worse, because it has not been proved that the compression of the head leaves much evil effect behind,† whilst by distorting the chest we interfere with the most important vital functions of the body.

When I am on the subject of female dress I may as well say that the tendency of the present fashions appears to be to restrain the free movement of almost every part of the body. The Mother Hubbard and Dolman cloaks pin the arms down to the already compressed chest, whilst the skirt of the dress is so tightly tied in behind the knees that only a very limited degree of movement is allowed at the hip-joints. With chest, arms, and legs bound up in this manner, like Egyptian mummies in their swathing bands or fowls trussed for the table, the only parts of the body which can move freely are the head and the lower-jaw. How can women expect to be healthy when they neglect one of Nature's great laws, viz., free exercise.

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* Pregnancy.

† Up to a comparatively recent period, French mothers, in certain districts, were in the habit of compressing the heads of their infants by bandages. In these cases very evil consequences sometimes resulted.

But I fancy I hear you say, "Is this not too sweeping a condemnation ? it is only a certain proportion of the sex which lace tightly and wear such apparel." I am quite willing to grant this, but there are very few women indeed who dispense with stays altogether, and however loosely these may be applied they give an artificial support to the spine, and thus detract from its inherent strength. Stays act exactly in the same way as a prop to a tree. It is a well known fact that whenever a tree becomes accustomed to the support of a prop it generally ceases to take strong hold upon the ground with its roots; it in fact relies upon the prop for its support. In like manner the stays weaken the spine. If a corset must be worn, then let it be one with no bones but composed of soft material quilted or corded.

SKULL.—Twenty-two bones enter into the formation of the skull, and these, with the single exception of the lower-jaw, are so firmly united the one to the other that little or no movement can take place between them.

The skull consists of two parts: (1) a portion belonging to the face, and (2) a capacious cavity termed the cranium or brain-case, which is developed for the purpose of protecting the brain.

The bones of the face are *fourteen* in number. They are placed below the forehead, and they are so arranged that they take part in the formation of the walls of the orbits—two deep recesses or sockets in which the eye-balls are lodged—the nasal cavities and the walls of the mouth.

In the lower animals the facial bones are prolonged forwards so as to form a projecting muzzle, which in great part lies in front of the cranium or brain-case. In man the facial bones lie almost entirely under cover of the cranium, and it is only in some of the lower races of mankind, as, for example, the native Australians and Negroes, that we observe a slight tendency to the projection of the jaws. This is a very beautiful provision of Nature. In the lower animals the fore limbs are organs of progression, and the jaws are prolonged forwards to act as organs of prehension. By them the animal is enabled to obtain its food. The prehensile arms of man render such a provision unnecessary.

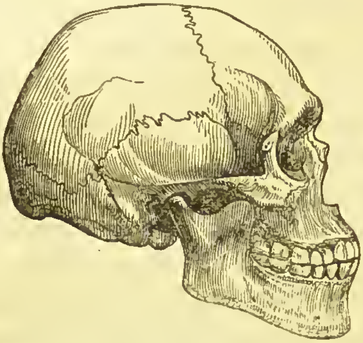

Fig. 5.
Skull of a native Australian (Carpenter).

The *eight bones* of the cranium are united to each other by their margins, and so firmly are they interlocked the one with the other that no individual bone can be removed without breaking up the whole fabric. When we wish to do this it is necessary to apply the force from within by filling the cavity with peas. These when moistened expand and break up the brain-case into its constituent bones. This shows how admirably it is adapted to withstand injury from without.

Taking a skull in our hand and turning its lower surface towards us we observe that its base is perforated every here and there by apertures. These holes are for the purpose of transmitting nerves and bloodvessels to and from the brain. One very large oval opening, called the *foramen magnum*, at once attracts our attention. It is situated just behind the middle point of the base of the skull, and when we place the skull in position upon the top of the spine, we notice that the foramen magnum lies immediately over the spinal canal. This hole, therefore, is the aperture through which the brain is continuous with the spinal marrow.

Upon either side of the fore part of the foramen magnum there is a small elevated smooth convex surface. These fit into corresponding sockets in the first vertebra, and in this way the head is poised upon the summit of the back-bone. In the lower animals these surfaces are placed much further back, but the erect attitude of man necessitates that they should be placed near the middle point of the base of the skull, so as to balance the head and prevent it pitching forward.

The form of the cranium is subject to considerable variation; indeed it is recognised by anatomists as being one of the best means of distinguishing the different races of man. We are in the habit of separating skulls into three groups, viz.: (1) *long-headed,* those which are very long as compared with their breadth; (2) *short-headed, i.e.,* those which are very short as compared with their breath; and (3) *medium-headed,* those which have a medium length and breadth, or those which occupy an intermediate position between the two extremes.

The negroes and aboriginal Australians are, as a rule, *long-headed;* the North American Indians are *short-headed;* whilst the inhabitants of Central Europe are for the most part *middle-headed.* The French are said to possess the most typical medium skulls. The form of the skull, however, cannot of itself be considered a sufficient indication of the intellectual powers of the individual. If this were the case, the French nation would perhaps occupy the highest position. A still more important factor to be taken into account is the capacity of the brain-case. As the cranium is completely filled with the brain, we can, by measuring its capacity, form an accurate estimate of the size of the brain which occupied it. Here again there are considerable differences in the skulls of different races. The European brain-case is considerably the largest, having an average capacity of about 91 c. inches; the average capacity of the Negro cranium, on the other hand, is only 85 c. inches, whilst that of the aboriginal Australian is as low as 79 c. inches.

But what a prodigious difference we find between the cranial capacity of man and that of the ape! Of all the points which distinguish man from his nearest of kin in the animal world this is the most striking. Speaking generally we may assert that the lowest cranial capacity which has been noticed in man is twice as great as that of the highest cranial capacity that has been noticed in the gorilla.

The next fact which I have to mention in connection with this subject is one which I fear will not meet with the approval of the fair sex. But it is a fact which I cannot suppress, viz., that the cranial capacity of the male skull is usually greater than that of the female skull. The average British male cranium has a capacity of 90 to 95 c. incles; the average British female cranium a capacity of 80 to 90 c. inches. The interesting point in connection with this is that there seems to be a greater difference in this respect between the two sexes of the higher races than between the two sexes of the lower races, as say between the negro and negress. If this statement be true (for it still requires to be verified), it would appear that civilisation causes a greater advance in men than in women. Carl Vogt explains this by pointing out that in low races such as the Australians and Bushmen, which possess no fixed habitations, "the wife partakes of all her husband's toils, and has, in addition, the care of the progeny."

The investigations of Paul Broca seem to point to the probability that the advance of civilisation in a people is accompanied by a slow increase in the cranial capacity. He had an opportunity of examining a large number of skulls of the Parisians who lived in the twelfth century. On comparing these with the skulls of the more modern Parisian population, he found that they had a decidedly smaller capacity.*

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* A discussion is going on at present in "Nature" regarding "an alleged diminution of men's heads." It seems that there is a prevalent belief amongst hatters that a diminution has taken place. A hatter who has been in business for a great number of years compares the ratio at which hats were purchased 35 years ago with the ratio at which he is at present selling them, with the following result :—

Size in Inches.	Relative Number of Each Bought.	
	Thirty-five Years Ago.	At Present.
21	0	3
21½	1	4
22	2	3
22½	4	1
23	3	1
23½	1	0

Professor Flower, who is perhaps the most eminent craniologist in this country, rightly refuses to receive "a fact so contrary to all theory and to all experience" until more exact and more extensive data are produced.

LIMBS.—At the commencement of my lecture I explained to you the principle which leads to the complexity of the animal body, viz., the principle of the division of labour. Now it has been established as a law by Milne Edwards, that the more completely this principle is carried out in an animal the more perfect is its mechanism. In a quadruped, such as the horse, all the four limbs are used for progression, and nothing else, save perhaps defence. The jaws are prolonged forward so as enable the animal to seize and obtain its food. Ascending some steps in the animal kingdom we come to the apes. In these the four limbs are still employed as instruments of locomotion, but each is in addition prehensile. Each, therefore, is endowed with a double function. The jaws are not nearly so prominent, and play but an inferior part to the limbs in the securing of sustenance. In man a still greater difference is found. The lower limbs are framed for locomotion alone, and assume the entire duty of conveying the body from place to place. The arms thus freed from this inferior work are devoted solely to prehension, and become the faithful ministers of the mind. The jaws also have retreated so as to lie altogether under the cranium, and the only function allotted to them is the trituration of the food. The three functions, therefore, of locomotion, prehension, and the trituration of the food which are distributed over the four limbs, and the jaws in the quadruped and the ape, are in man each performed by its own instrument—the labour is thus divided, and man in consequence presents a more perfect organism. But you may ask what advantage is gained by this arrangement? I will answer this Scotch fashion by putting another question. Whether is it better to have in a house three general servants, or three servants—one a trained cook, another a trained housemaid, and the third a trained tablemaid? Am I not right in supposing that the work will be better done by the latter than by the former. The case is quite the same with the human body.

The lower limbs of man then are entirely devoted to locomotion, and in consequence of this they possess a length and a development far beyond that of the most man-like ape. The prehensile upper limbs, on the other hand, are not nearly so powerful, and are very much shorter. In the European, when the body is erect the middle finger cannot reach lower down than the middle of the thigh; in the negro it reaches a little lower. The orang when erect can touch his ankle with his fingers; the gorilla can touch the middle of his leg, and the chimpanzee his knee.

Let us now, very briefly, look at some points in the construction of the limbs.

In the *lower limb* we recognise a haunch, thigh, leg, and foot. The skeleton is composed of the following bones:—(1) The haunch-bone; (2) the thigh-bone; (3) the knee-cap; (4) the two bones of the leg; and (5) the bones of the foot.

The *haunch-bones* of opposite sides are firmly jointed together in front. Behind, the sacrum—which you will remember is a bone formed by five of the lower vertebræ, welded together—fits in between them like the key-stone of an arch. The weight of the body is thus transmitted to the lower limbs, and at the same time a cavity is formed which is termed the *pelvis*, so called because it resembles a basin.

The upper portions of the haunch-bones are widely expanded. By this character the haunch-bone of man can be distinguished from that of all other animals. The expansion is rendered necessary by the erect posture of the human body, and it is developed for the purpose of giving support to the intestines. In quadrupeds the weight of the bowels is sustained by the flaccid lower wall of the abdomen, and this is strengthened for the work in large animals, such as the horse, by a powerful elastic tunic, which not only prevents relaxation of the abdominal wall, but also by its elasticity guards the viscera against shocks.

The *thigh-bone* is the longest and most massive bone in the body. Its upper end presents a smooth globular head which fits into a deep cup-like socket upon the side of the haunch-bone, and forms the hip-joint. This rounded smooth head of the thigh-bone is not placed upon its very extremity, but is separated from the shaft of the bone by a constricted neck which joins the shaft at an angle. By this means a much wider range of movement is allowed at the hip-joint.

At this stage I must say a word or two upon *joints*. I will not speak of the immovable joints, such as those between the bones of the skull where the junction is effected by the interlocking of toothed margins. Nor will time permit of my describing to you the partially movable joints such as those between the two haunch-bones in front and between these bones and the sacrum behind. I will simply direct your attention to a few leading points in connection with the truly movable joints, such as we find between the bones of the limbs.

In such joints the opposed surfaces of the bones are each coated with a thin layer of exceedingly smooth elastic cartilage or gristle. This acts in precisely the same manner as the buffers of a railway carriage. When you reflect then that in these joints every bone is separated from its neighbour by two such layers, you will understand the high elasticity and springyness which, by this means alone, is given to the skeleton, and how we are able to carry our bodies about with us with so little inconvenience from external shocks and jars.

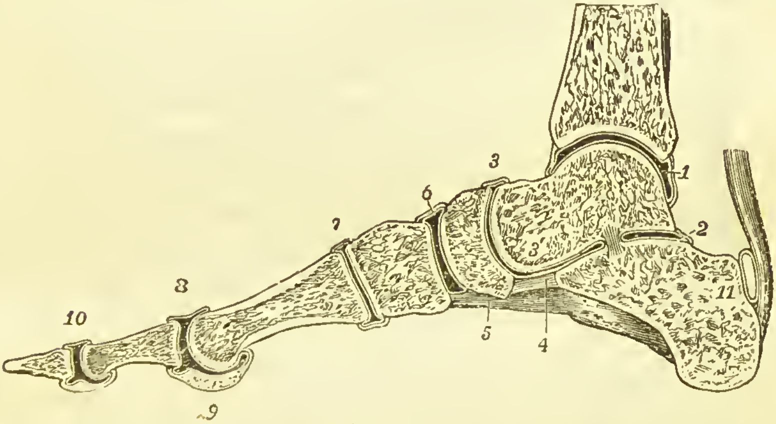

Fig. 6.
Section through right foot, from centre of heel to tip of the great-toe, to show the joints (Quain.)

Binding the bones together at a joint there are a series of strong membranous bands called ligaments. One of these is usually placed upon each of its four aspects, and they are frequently converted into a continuous and unbroken ligamentous envelope or capsule for the joint by intermediate and thinner membrane which passes between their margins.

A third and very important element in the formation of such a joint is an exceedingly thin membrane called the *synovial* *membrane*, which lines the inner surface of the ligaments. It presents a polished glistening surface, from which exudes a viscid fluid—the joint oil. This lubricates the interior of the joint, and allows the cartilage covered ends of the bones to glide smoothly upon each other.

The two bones of the leg lie side by side. They are (1) *shin-bone* on the inside, and (2) the *fibula* upon the outside. The shin-bone is a heavy massive bone, which receives from the thigh-bone the entire weight of the body. The fibula does not reach so far up as to take part in the formation of the knee-joint. The *knee-cap* is a bone with which you are all familiar. It forms the prominence of the knee, and protects the joint from the front. The fibula is a long slender bone, which is jointed above and below to the upper and lower ends of the shin-bone. Its lower end forms the projection on the outer side of the ankle. The corresponding prominence on the inner side of the ankle is formed by the lower end of the shin-bone.

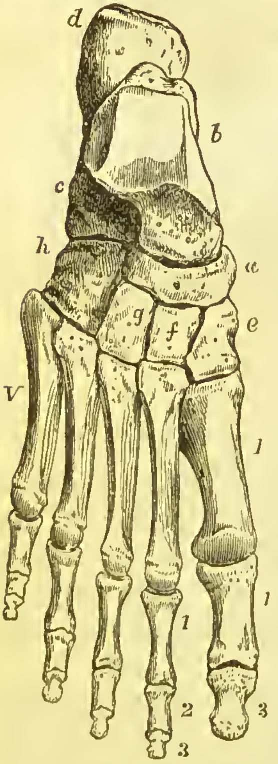

Fig. 7.

a, b, c, d, e, f, g, h bones of tarsus; i to v bones of metatarsus; 1, 2, 3 phalanges of great and second toes (Quain).

The mechanism of the foot is so beautiful and so characteristic of man that I must dwell a little more fully upon it.

There are *twenty-six* bones in the human foot. Of these the hinder *seven* are short and stout, and constitute what anatomists call the *tarsus, i.e.*, the back part of the instep. In front of the tarsus there are *five* prismatic bones, which are jointed to it, and which lie side by side. These are termed the *metatarsus*, and they form the front part of the instep. The anterior rounded ends of the five bones of the metatarsus rest upon the ground, and are popularly known as the balls of the toes. Each metatarsal bone supports a toe, and each toe, with the exception of the great toe, is formed by three bones placed end to end. The great toe has only two such bones. The toe bones are called phalanges, from being placed in rows like soldiers in a phalanx.

The seven bones of the tarsus, together with the five bones of the metatarsus, constitute an arch, termed the *plantar arch,* the height and span of which is greater upon the inner than upon the outer aspect of the foot. The key-stone of this arch is formed by the highest of the tarsal bones—a bone called the *astragalus* (fig. 7, *b*), This bone supports the entire weight of the body, being clasped between the inner and outer ankles, and it transmits its burden to the summit of the arch. The hinder pillar or pier of the arch is formed by one bone, viz., the heel-bone, which is the largest of the tarsal bones, whilst the anterior or front pillar is formed by several bones. In consequence of this the anterior pillar is highly elastic, and the posterior pillar almost rigid, and therefore, when we jump from a height, we make it an invariable rule to descend upon the balls of the toes, and thus break the shock which we would receive were we to land first upon the rigid heels.

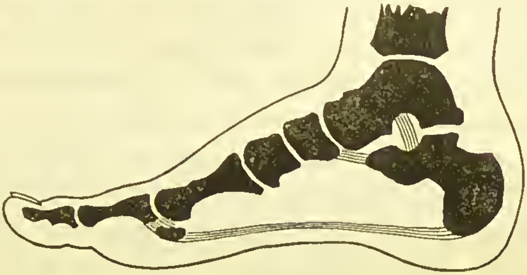

Fig. 8.

Section through foot, from centre of heel to tip of great toe, to show the plantar arch. *See* also Fig. 6.

The bones of the plantar arch are held together by dense ligaments. Of these two are specially important for maintaining the arch of the foot. One is a powerful and non-elastic brace, which stretches between the extremities of the pillars, viz., from the under surface of the heel-bone to the balls of the toes (Fig. 8). This ligament, as Professor Humphry has pointed out, acts in precisely the same manner as the tie-beam of a roof. It prevents the pillars of the arch from being pressed too far apart when the weight of the body, and anything it may be carrying, is transmitted to the foot. The other ligament, I wish to refer to, is highly elastic—just like an indiarubber band. It passes between the heel-bone and one of the tarsal bones which lies in front of it, and the rounded end of the astragalus or key-bone rests upon it (Figs. 6 and 8). When the weight of the body is thrown on the astragalus this ligament gives by virtue of its elasticity, and the key-bone sinks. When the weight is removed the ligament recovers itself, and restores the bone to its former position. The foot therefore gains greatly in elasticity by the presence of this ligament, but it will be easily seen that this gain gives rise to a weak point in the *plantar arch.* In people with weakly constitutions, or when the foot is subjected to great and continuous strains, as in ballet dancers, or bakers who carry heavy loads of bread upon the head, this ligament may become relaxed, and the result is that deformity of the foot which we all know as "flat foot." This then consists in a destruction of the plantar arch by the descent of the astragalus.

The foot of man is one of the great structural distinctions of the human species. In none of the apes have we a perfect plantar arch, and in none have we so great a development of the great-toe. In man the great-toe possesses a very small range of movement; in the apes it is highly mobile, and resembles in this respect the thumb of our own hand. We must not forget, however, that the capabilities of our foot are greatly interfered with from its being encased in a boot. Every one has noticed the wide range of movement possessed by the toes of an infant. Further, it is a well known fact that in bare-footed people the toes may attain a considerable amount of grasping power. Thus the Australian natives can lift their spears by the foot; the Chinese boatmen can pull an oar; and the natives of Bengal can weave. Not very long ago in Belgium, a gentleman who had been born without arms attained distinction as an artist by wielding the brush with his feet.

We have seen how cruelly fashion deals with the female waist. It is almost as cruel to the foot. An immense amount of pain and misery lies at the door of the shoemaker—corns, bunions, in-growing toe-nails—and all because a boot made according to the true shape of the foot is considered to be clumsy and inelegant.

Let me point out to you what the true shape of the human foot is. I need not ask you to look at your own feet in illustration of this. Thanks to your shoemakers,* I don't believe that there is a foot in this hall which is quite free from deformity. We must examine feet which are altogether unacquainted with shoe-leather, such as those of an infant or a bare-footed urchin. In such a foot we notice that the toes are widely spread out, and that the great toe stands free from the others. If we draw a line from the centre of the heel along the sole to the extremity of the middle toe, and another backwards through the middle of the great-toe, the axis of the great-toe is seen to be parallel with that of the foot. How different is the shape of that part of the ordinary boot which encases the toes. The sole is pared away on each side so as to make it pointed in front, or, as Mr Dowie has remarked, as if "a great-toe was in the middle and a

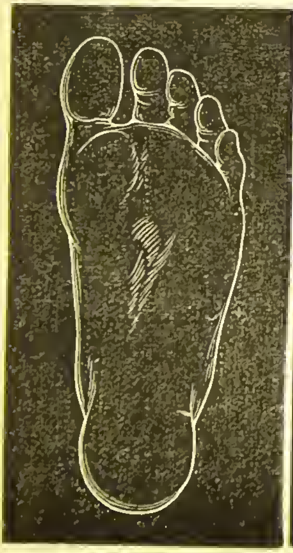
Fig. 9.
Natural foot.

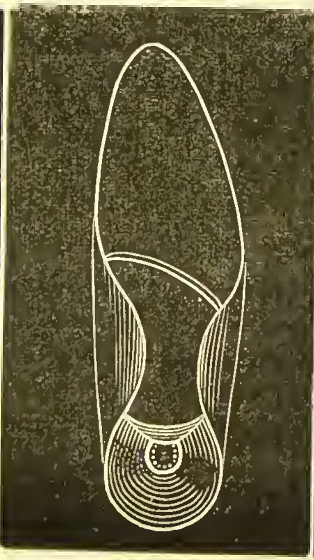
Fig. 10.
Outline of the sole of an ordinary boot.

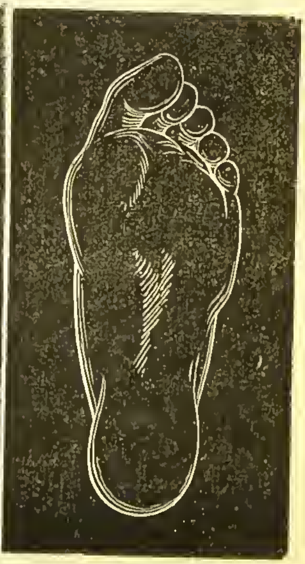
Fig. 11.
The common condition in which feet are found. Great toe deflécted outwards.

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* Of late years shoemakers have been paying more attention to the shape of the foot, but there is still a very great need for reformation in this respect.

little toe on each side like the foot of a goose." In consequence of this the toes are crushed together to such an extent that it is not at all uncommon to find one or more thrust upwards or downwards to make room for the others. The great-toe is deflected outwards, so that its direction is no longer straight but oblique. This is harsh treatment for that member which, above all others, we should prize, seeing that it constitutes one of the chief structural distinctions between the human foot and that of the ape. But this is not the worst feature of the case. In walking, running, and jumping the great-toe is the chief agent in the foot for giving to the body the final push as the foot is being lifted from the ground. By looking at these diagrams you will understand how much its action is weakened in this respect when it is forced outwards by a pointed boot.

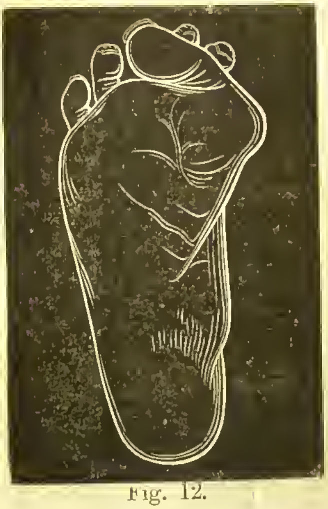
Fig. 12.
A sketch obtained from the deformed foot of a woman only two days before this lecture was delivered.

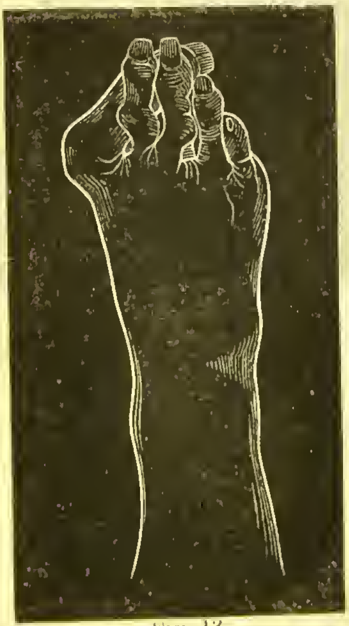
Fig. 13.
Same foot as in Fig. 12, dorsal view

Had time permitted I would have liked much to have pointed out how the present conventional boot might be improved in its shape. I must simply refer you for information on this to a little pamphlet called "Why the Shoe Pinches," by Professor Meyer.

I must not leave this subject, however, without entering a strong protest against the high narrow heels which usually adorn the fashionable ladies' boot. I have had this diagram prepared in order to show you some of the consequences resulting from these.

The plantar arch is distorted; the posterior pillar or heel-bone is so raised that the weight of the body is not distributed equally over the arch but is thrown mainly upon the anterior pillar. In order to maintain the equilibrium of the body, the knee has to be kept slightly bent, and the invariable result is a wasting of the muscles of the calf, and a weakening of the whole limb. But this is not all. The heel-piece is seldom placed directly under the heel-bone or posterior pillar of the plantar arch. In great part it presses directly upwards against the tie-beam ligament of the foot into the hollow of the arch. Now in this hollow are placed the blood-vessels of the foot, and they are placed there for the purpose of escaping pressure when the foot rests on the ground. By the high heel this provision of nature is defeated, the circulation is interfered with, and the results are cold feet, and in winter a proneness to chilblains. Why should ladies simulate a practice which they ridicule so much in Chinese women?

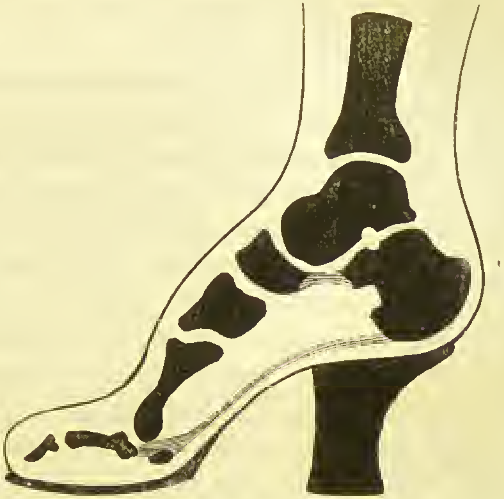
Fig. 14.
Outline of modern ladies' boot.

In the *upper limb* we recognise a *shoulder*, an *arm*, a *forearm*, and a *hand*.

Entering into the construction of the shoulder there are two bones—the collar-bone and the shoulder-blade. Together these constitute a part of the skeleton which we are in the habit of calling the *shoulder-girdle*, seeing that it partially encircles the upper part of the chest on either side.

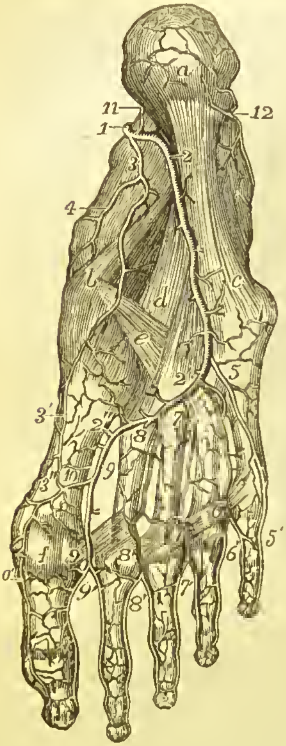

Fig. 15.

Sole of the foot dissected to show the bloodvessels. 1, 2, 3 main arteries of the foot (Teidemann).

The *collar-bone* stretches from the upper end of the breast-bone to the shoulder-blade, to both of which it is firmly jointed.

We have to thank the collar-bone for the wide range of movement which we possess at the shoulder-joint. It acts as a prop to keep the shoulders apart, and in those animals in which it is absent, as, for example, the horse and the ox, the limb can only be moved backwards and forwards. The advantage which is thus gained by the shoulder of man is attended with some risk. The projection of the shoulders renders them very liable to injury. Indeed, fracture of the collar-bone, and bruises and dislocation of the shoulder-joint, are about the commonest injuries that come under the notice of the surgeon.

I don't think that we would readily admit any superiority of carriage in French women as compared with the women of our own country. Still it has been asserted that in the former the collar-bones are slightly longer, and that they are thereby enabled to carry themselves with more grace.

The *shoulder-blade* is a flat triangular bone which lies upon the back of the upper part of the chest. At no point is it directly jointed to the bones of the trunk. Indeed, the only direct articulation between the upper limb and the trunk is where the collar-bone is jointed to the breast-bone.

In the upper-arm there is a single long bone—the *arm-bone* or *humerus.* The rounded upper end of the arm-bone rolls in a hallow concavity or socket which is developed on the upper and outer angle of the shoulder-blade.

In the forearm we find two bones placed side by side and extending from the elbow to the wrist. Of these the outer is termed the *radius*, and the inner the *ulna*. At the elbow-joint the ulna is very extensively connected with the arm-bone or humerus; indeed it holds the lower end of the latter in a deep crescentic concavity. The upper end of the radius is very small, somewhat disc-shaped, and in contact with the lower end of the humerus by its upper surface alone. If we now compare the lower ends of the bones of the forearm, we notice that the lower extremity of the radius is broad and expanded, and takes the chief part in supporting the hand, whilst the lower end of the ulna is small and button-shaped, and is separated from the bones of the wrist by a triangular piece of cartilage or gristle. Whilst then the ulna has a greater share in the construction of the elbow joint, the radius predominates at the wrist joint.

Now the radius, with the hand which is fixed to its lower end, is capable of performing two very important movements. These movements are termed *pronation* and *supination*. I have said that the radius lies to the outer side and parallel with the ulna. When the bones have this relative position the arm is *supine*. This is the position which is assumed when we lay the back of the hand upon a table so that the palm looks upwards. Reversing the attitude, however, and placing the palm of the hand upon the table, we produce *pronation* of the limb. The relative position of the two bones of the forearm is now altered. The upper end of the radius still lies upon the outer side of the ulna, but the large lower end of the radius with the attached hand has rolled over the small button-shaped lower end of the ulna, so as to lie upon its inner side. The two bones in this condition cross each other like the limbs of the letter X.

In the hand there are three segments, viz., the wrist, the palm, and the fingers.

Entering into the formation of the wrist there are eight small bones, called *carpal* bones, arranged in two rows—four bones in each row. These are so accurately fitted the one to the other and are so firmly bound together by ligaments that it is very rare indeed to find them displaced by an injury.

The soft parts of the palm are supported by five prismatic bones called *metacarpal* or knuckle bones. These are placed side by side, and are jointed above to the lower row of carpal bones. Each knuckle bone is succeeded by the bones of a finger, which like the corresponding bones of the toes are called phalanges. The inner four fingers have each three phalanges, whilst the thumb has only two.

The hand of man is essentially a grasping instrument, and its high capabilities in this respect are due to the great mobility of the thumb, and the power by which this digit can cross the palm so as to touch the tips of all the other fingers. So important is the hand to the well-being of man that there are some who consider the high mental superiority which man shows over all the lower animals, in great measure due to his being the possessor of so perfect a prehensile organ. Whether this be the case or not, it is at least certain that the mind and the hand are mutually dependent. What use would the mind be to us for inventive purposes had we not the hands to carry out the invention to its practical results.

The ape alone amongst the lower animals can imitate the movements of the human hand, and this very imperfectly. Throw a nut to a monkey and he will pick it up—not between the tips of the fore-finger and thumb—but between the thumb and the side of the bent fore-finger. In many respects the hand of the ape is inferior: thus the thumb is shorter and less mobile; the fingers cannot be so widely separated; and there is little or no power of making the "hollow of the hand."

MUSCULAR SYSTEM.—I have now given you a very brief and I fear a very inadequate account of the bony-scaffolding of man. We must next consider the means by which this is maintained in the erect attitude; how it is that its various parts are moved the one upon the other; and how it is that the skeleton as a whole moves from place to place. All this is due to the *Muscular System;* not the smallest twitch of an eyelid—not the slightest change in facial expression can be affected except through the agency of *muscles.*

The muscles constitute the red flesh, or what is perhaps better known as the "lean" of the body. There are somewhere about 400 muscles in the human subject. Everyone has seen a leg of mutton cut across the middle, and has observed the red flesh around the bone. No doubt you have also noticed that this red flesh does not constitute a uniform mass, but is sub-divided into unequal variously shaped areas by white lines, representing fibrous partitions. Now each of these areas represents a separate muscle, and if, in a limb before it has been detached from the body, you were to follow this muscle by dissection upwards and downwards, you would find that the fleshy mass ends at either extremity in a sinew or tendon; and further, that by these sinews it is attached firmly to the skeleton. Understand this, however, that the upper and lower tendons of a muscle are never attached to the same bone, but always to different bones.*

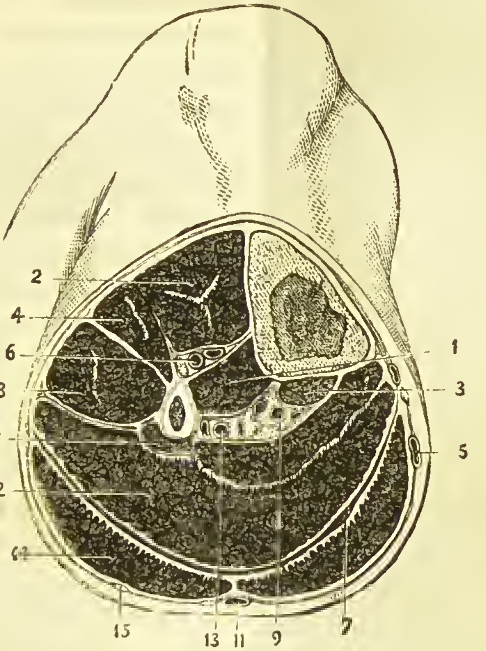

Fig. 16.

ection through leg, 1, 2, 3, 8, 10, 12, 14 various muscles; 9, 13, 11, 6, and 5 bloodvessels, The larger bone is the shin-bone, and the smaller the fibula (Heath).

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* I refer here to the majority of the muscles. There are some which are attached only by one end to the skeleton, such as those which move the eyeballs and the skin of the face ; a few, indeed, can hardly be said to have any attachment to the skeleton, as, for example, a little muscle on the inner side of the palm, which wrinkles the skin and deepens the hollow of the hand.

In the human body, then, we have this enormous number of muscles passing from bone to bone, clothing them and connecting them together. But how, you ask, do they produce the movements of the body? They perform this by their power of contracting; every muscle is capable of shortening itself, and thus approximating its terminal tendons and the bones to which these are fixed. The tendons have no contractile power. They act therefore just like the traces which connect the horse to the cart —they play a passive part.

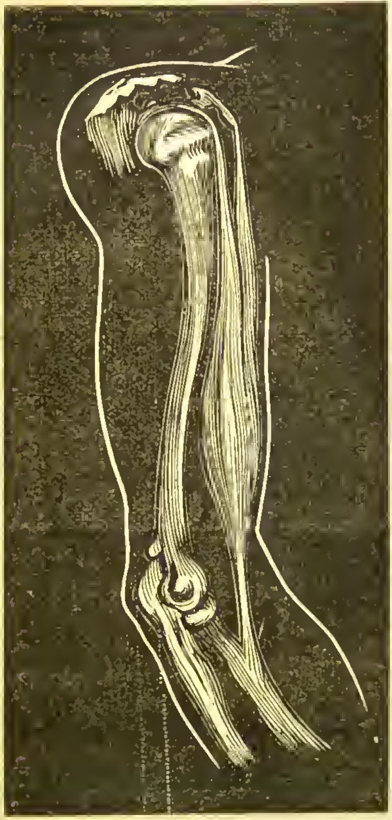

Fig. 17

Forearm extended, Biceps muscle relaxed and at rest.

Let me illustrate this to you by taking one muscle as an example. I will choose for this purpose one with which you are all familiar, viz., the *biceps*. This muscle, as you know, forms the projecting mass in front of the joint of the upper arm, where the limb is bent forcibly at the elbow joint. Above it is attached by two separate tendons or heads (hence its name biceps) to the shoulder-blade; below it is fixed by a cord-like sinew to the radius or outer of the two bones of the forearm a short distance below the elbow. When it contracts, it bends the forearm at the elbow, like a door upon a hinge; and as the contraction of a muscle is always accompanied by a corresponding thickening, or increase in breadth, we have a marked prominence produced in front of the arm.

For the performance of voluntary motion, something more is required than the mere muscles. Each muscle must be brought under the influence of the nervous system; therefore entering it we always find one or more nerves. These nerves connect the various muscles with the brain and spinal marrow, and by them the movements of the body are excited and controlled. The influence of the nervous system in this respect is manifested by the effects produced by intoxication, or by the disastrous results following apoplexy. The tottering gait and the double vision of the drunkard are caused by the alcohol acting upon the nervous system in such a manner that it is rendered incapable of producing harmonious contractions of the muscles. The sudden collapse of the frame, when apoplexy occurs, is due to a destruction of brain-matter from the rupture of a small bloodvessel, and the pouring out of the blood into its substance.

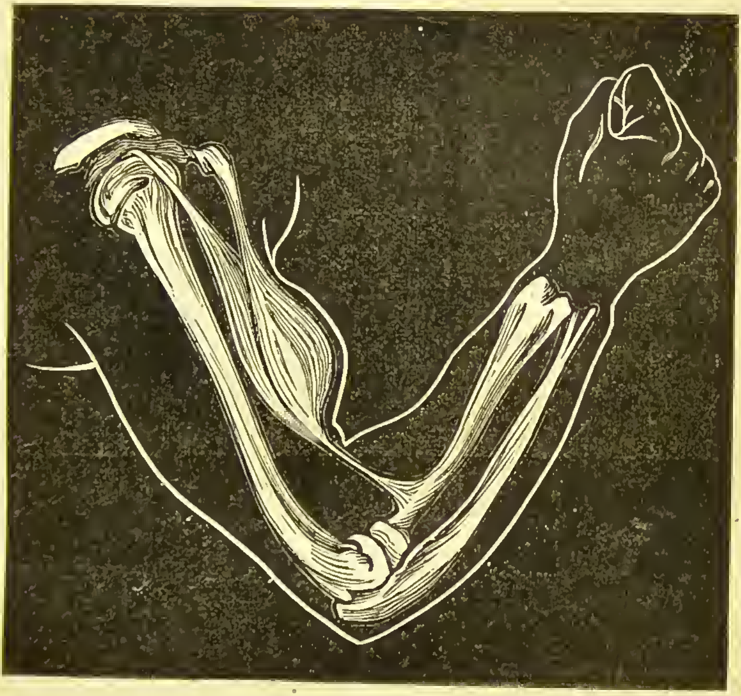

Fig. 18.
Forearm flexed at the elbow joint. Biceps in contracted condition.

In addition to the nerves, each muscle is entered by bloodvessels—arteries to carry blood to the muscle, and veins to drain it away. The blood supplies the muscle with the energy requisite for its proper contraction.

Before I finish, let me urge upon you the necessity of exercising the various muscles of the body. Allow a muscle or a limb to lie unemployed, and it shrinks and wastes. A good physique and a graceful bearing can only be acquired by giving each part of the body its proper amount of regular exercise. But exercise is of value not only for the muscular and skeletal systems—it is an essential for the right performance of every function in the body.

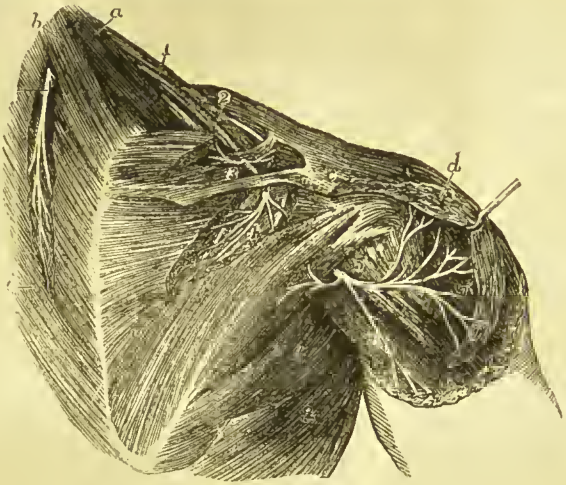

Fig. 19.
Nerves entering muscles of shoulder (Hirschfeld and Leviellé).

I am now finished. I have confined myself almost entirely to bones and muscles. Dr Tuke will introduce the brain into the cranial cavity. Dr Jamieson will clothe the body with its protective covering, the skin, and Dr Foulis will fill the cavity of the abdomen with the organs of digestion. Last session the contents of the chest cavity were fully described to you.

PARASITES,

IN THEIR RELATION TO FOOD AND HEALTH.

WITH ILLUSTRATIONS.

By Dr ANDREW WILSON, F.R.S.E., F.L.S., &c.,

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Mr Chairman, Ladies, and Gentlemen,—There can exist no doubt that the idea which is evoked by the term parasite is anything but an agreeable one. For, if we even look at the name as it has been metaphorically applied to certain individuals of the human species, we shall find that the term indicates a cringing, despicable unit of humanity, who, as in the days of ancient Rome, was ready to follow at his patron's heels, and to execute any commission however base or ignoble, which that patron might command. And when we turn to the purely scientific aspect of the term "parasite," the associations connected with the name are again anything but agreeable. But life is not all "sweetness and light;" it has its unsavoury but apparently necessary side as well; and a very important necessity exists for our knowing something, not merely about the nature of parasites, and about the ranks of the animal and vegetable worlds from which they are derived, but also concerning their special effects upon the human organism and upon the bodies of lower animals as well.

The importance of this subject, in so far as the general public are concerned, will be best demonstrated by a reference to "parasites" as they affect our food-supply and our health itself. But I should first desire, in commencing my lecture to-night, to ask your attention to a correction of one or two ideas concerning "parasitism" at large. We are too apt, from that popular standpoint, which utterly neglects the conclusions of natural history science, to regard a parasite as being a thoroughly unnatural animal. Now, the naturalist, in reference to the history of any animal form, considers, amongst other details, its "distribution," and in so doing has his attention directed to the different quarters or "areas" of the world which animals and plants are found to occupy. When, therefore, we study the bodies of animals and plants in this light, we discover that a very large and important area of habitation is opened up for animals and plants of a lower kind. We learn that it is not in the least unnatural, if we may judge by the frequency of the habit, for one animal or plant to live in or upon another living being—animal, or plant, as the case may be. In fact, the more we know about this subject, in a purely biological or zoological sense, the wider we discover the sphere of the parasite to be—so wide, indeed, that in one sense it may almost be said to be co-existent with life itself. The words of the witty Dean Swift apply most aptly to the wide distribution of parasitic life:—

So, naturalists observe, a flea
Has smaller fleas that on him prey,
And these have smaller still to bite 'em,
And so proceed *ad infinitum.*

These words undoubtedly contain a large amount of scientific truth. For, in many cases, we may find even the parasite itself to be assaulted by humbler life. But, in any case, the wide distribution of the parasite, and the thoroughly natural character of the parasitic home and habitation, is a zoological idea which may well be impressed upon you at the commencement of this lecture.

In taking a brief and general survey of parasitic life, we may begin with the lowest fields of plant existence, and pass upwards to the highest animal life—that of man himself, who is not merely not exempted from parasitism, but who presents special attractions for the ravages of certain kinds of these organisms. To commence with the very lowest rank of life, we find many of the so-called "germs" which are almost undiscoverable by the highest powers of our best microscopes, presenting themselves under a parasitic guise and habit. Many of you will remember that at the recent meeting of the Social Science Congress in Dublin, Dr Cameron read a paper detailing the results of Pasteur's observations in connection with the organism which has been found to cause *splenic fever*, a peculiar disease, otherwise known as *charbon* and carbuncle, or, in popular English, "a plague of boils," which affects sheep, cattle, and other animals, and may be transmitted from them to man. The researches of M. Pasteur have proved that this disease is caused by an organism, probably a plant, of the humblest grade; the full history of which takes almost the scientific work of a lifetime, and a patience excelling Job's, to discover. Then, passing from these "germs," which undoubtedly are the causes of our zymotic diseases and fevers, to parasitic plants, we find illustrations of parasitic habits in certain plants, several of which will be perfectly familiar to all. For instance, take a plant which will acquire historical and social importance a few weeks hence—the mistletoe. This plant is a parasite of the oak and the apple tree. Yet, it is not a perfect parasite, because, having green leaves of its own, it can, to a certain extent, make food for itself. The parasitic plant known as "dodder," which ruins our crops when growing in abundance through a process of literal strangulation, is a purer parasite than mistletoe, in that it is dependent for food on the plants to which it pays its nefarious attentions. But if you study the history of lower plant life more intimately, you will learn that nearly three-fourths, if not a larger proportion, of the skin-diseases of man are caused by lower vegetable growths. Thus, for example, you have the *tinea* or "ring-worm," caused by a low fungus called *Tricophyton* by botanists. Then, again, you have *favus* affecting the scalp, and that again is a skin-disease caused by a fungus of another kind called *achorion*. There is also another well-known skin-disease—which is in fact a genus of skin diseases, having a considerable number of species or varieties—called *herpes*, which not only affects man, but which may be transmitted from him to animals. This also is the direct result of the growth of a particular kind of fungus in the skin. We thus discover that the lower orders of plants possess, even in the domain of human life, a very wide area of distribution. And passing to a lower life-form still, we shall discover the silk-worm to be affected likewise by a parasitic form of plant life. In other words, we shall have to recognise as a pest of the silk-insect, the small *Botyrtis*, a microscopic plant, which nearly ruined the commercial prosperity of France a few years ago, in so far as the silk-producing industry was concerned by causing the *muscardine* disease.

I need not say more on this head to show you how life in its lower deeps possesses relations of importance and interest with life in higher ranks, or even its highest grades. We may now try to trace, in order to obtain an intelligent view of our subject, how parasitism begins. We shall find that this condition, like most other conditions of animal life, exhibits grades and stages advancing from small beginnings towards a more perfect and representative type. We may, perhaps, make clear the relations between parasites and the animals they affect through the use of an extremely common-place metaphor. How, for instance, should we define, in social life, the relations existing between the "lodger" and his "host" or landlord? Probably by saying that the former received shelter from his host, but was not dependent on him for anything else in the way of food. More plainly, the pure "lodger" has to do his own cooking and providing; and so the first class parasites we shall call "animal lodgers."

In a diagram before you, there is represented the animal known as the sea-anemone. The poet Southey long ago called them "animal-flowers;" and as you see them in the rock pools of the Firth of Forth, or indeed in any other locality, you can realise the beauty and applicability of the poet's simile. It is a creature entirely flower-like in its appearance; with a central mouth, surrounded by a perfect array of tentacles, adapted for capturing the prey in the shape of the unwary crabs that stumble against them. Now, it is a well-known fact that some of the large species of tropical sea-anemones act the part of "hosts" to certain small fishes. The fishes have been seen to swim in and out of the mouth of the anemones, and are known to dwell in their body-cavity. This relationship becomes the more surprising, when you reflect that a single touch of your finger, far less placing your finger within the mouth, causes the anemone at once to contract itself in the fashion represented in the diagram and to become, from a flower-like form, a mere conical mass of jelly. Place that fact in relation to the previous one, and I think you can readily understand the beginnings of the parasitic life here. For, however the association began, the fish may be said to be a mere "lodger" within the body of the anemone. It feeds outside the host's body, or, in other words, "dines out;" but the curious fact of its lodging safely within the body of an otherwise voracious animal, remains to illustrate a new phase of placing one's head "in the lion's mouth."

Passing from the relation of the mere animal "lodger," we find a something added to the functions of the latter, when we discover that some animals literally "board" as well as "lodge" with another animal. The "boarder" in human life, is not merely taken in by the host, but he is taken in, and, in polite parlance, "done for." Here, however, we may realise some examples of what is said to be the practice of some sharp "boarders" in human life—that of "taking in" and "doing" their landlords. If we reflect, at least, upon the harm the parasitic boarder, living in the very kitchen, or digestive system of its "host," may do to the latter, we readily see the analogy between the dishonesty of the human, and the harm of the animal parasite. Here, on the wall before you, is a very well-known parasite called the *Sacculina* (fig. 1. A), which attaches itself to the bodies of hermit crabs. The Sacculina may be said to be

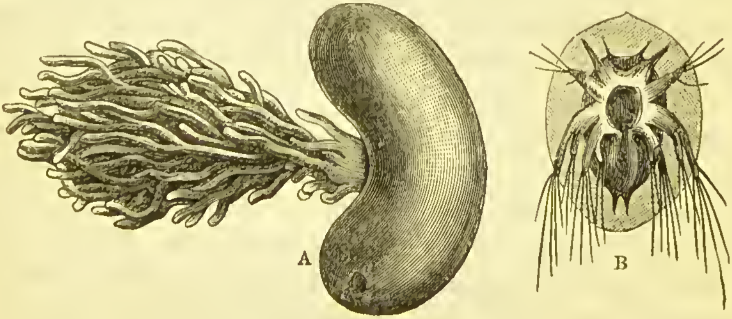

Fig. 1.

SACCULINA—A, Adult, showing the roots of attachment. B, Young *Sacculina* or *Nauplius*.

merely a sausage-shaped sac or bag. Suppose, then, we have such a sac-like animal, without any definite internal organs, but from whose body a number of roots grow into the crab's liver, we may thus discover a parasite, not merely depending upon its host for lodgment, but one which also feloniously abstracts from that "host" the nourishment it provides for its own wants. The history of a *Sacculina* is, however, worth a moment's study. This curious organism begins life as a little free swimming animal (fig. 1. B), possessing three pairs of legs, and called a *Nauplius.* It has an eye in the middle of the body ; but it possesses no internal organs, however, and it bears a resemblance to those animals called "water-fleas," which as many of the citizens of Edinburgh will remember attracted a considerable deal of zoological attention, on the promulgation of a certain defunct water scheme. Indeed, the Sacculina stands somewhat in the position of a "poor relation" to the "water-fleas" themselves. But a noteworthy fact in the history of the Sacculina, is that this sac-like parasite, itself a lodger and boarder on the crab, starts life under the guise of a water-flea, and only drops its legs and other organs when it settles down ultimately into the parasitic condition. For, after a free swimming life, the little Sacculina loses its legs and its eye, and, attaching itself to the crab, develops its roots, and becomes the mere pulsating sac (A) I have described. It thus furnishes us with an example of an organism becoming degraded, or backsliding, as it were, from a higher to a lower condition. And its history teaches us, amongst other things, that the original condition of most if not all parasites is a free-living state. Their parasitic habits, like habits amongst ourselves, are things which grow by degrees, and in time become the normal way of life. But in the case of a third series of parasites, the history of which I am about to describe, we shall find animals which are not merely "lodgers" or even "boarders," but in addition may be called "tenants by right." If we study the tape-worm or the fluke —the former inhabiting the alimentary canal of man or of the other warm-blooded animals, and the latter living in the bile ducts of the sheep's liver—we may discover that these parasites are not merely in a position to obtain lodgment and food at the expense of their hosts, but may be said to be in their whole history "tenants by right." They pass through the whole course of their development within the bodies of their hosts; and they select, through the operation of the laws of their life, a particular position, which they come to acquire as their lawful and natural area.

We thus find that parasites may be conveniently classified into (1) pure "lodgers," a condition representing the beginnings of parasitism; (2) "boarders," or that more advanced state wherein one animal becomes dependent on another for food as well as for lodgment; and (3) "tenants by right," under which class we find the most typical parasites, dwelling usually in one particular part of the animal which they affect, and in that part or organ alone. Parasitism, as I have already remarked, has its degrees and stages of perfection; and this observation, therefore, clearly shows that it is an acquired, and not original, condition.

The human area and its parasitic tenants may now engage our attention. It is in this department of inquiry that the main current of our thoughts to-night may be said to flow; and it is in this aspect of our subject that its relations to health are most clearly to be traced.

The human area, it may be remarked, presents a very considerable number of parasites for the notice of the naturalist. Some of these are harmless, others are annoying, and others, again, are of a highly dangerous character. As an illustration of the harmless type of parasite, we may select one which, as it happens, has no common name, but only a scientific appellation. It is called

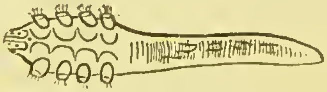

Fig. 2.
Demodex, a mite inhabiting the follicles of the human skin.

Demodex (fig. 2), and its specific name is *folliculorum*—a name indicating that it inhabits the little crypts or follicles of the human skin. There is one position in man which it invariably occupies, and that is the follicles of the skin at the sides of the nose. Its average length is about the eightieth part of an inch. It is unquestionably a kind of mite, but it exhibits that degradation of structure which we have noted to be the results of parasitic existence. It resembles the ordinary mites in having four pairs of legs, and in other characteristics of the class ; but we discover that the legs have degenerated to form mere stumps, so that the animal, in obedience to the law of use and disuse, and having no need of limbs, has become limbless accordingly. It is believed on the best authority that very few individuals are exempt from this parasite. Some statistics say forty out of sixty persons possess Demodex as a tenant; others maintain the proportion to be one in ten. We are ignorant of its existence, very probably, from the fact, that it is so thoroughly harmless. But in the dog it may give rise to annoyance, as it has been estimated that in a single follicle of the dog's skin no fewer than 200 of these parasites may be found. The dog, therefore, exhibits in an increased degree a condition which is harmless in man. The species which affects the dog is slightly different from that which exists in man. In Demodex, then, we see illustrated a case of pure parasitism, but one, at the same time, of a harmless kind. Very different, in the results of its life at least, is the parasite which produces the disease known as "itch." This parasite is likewise a mite, the female of which burrows beneath the skin, and forms regular channels or galleries in that tissue. This mite also exemplifies the operation of the law in parasitism that degeneracy follows disuse, for the two hinder pairs of legs are only partly developed. It is a well-known fact that in the case of this mite unhealthy conditions of body, or want of attention to personal cleanliness, are predisposing conditions for its attacks; preparing the skin, as a soil is prepared for the seed, to become the habitat of this animal.

The parasites which next await us, bring us directly within the domain of the physician and sanitarian. All parasites are not of equal importance in relation to human health. In one case a parasite, such as the *Trichina*, may affect man so powerfully that its invasion may be attended with a fatal issue. There are other parasites, such as the tape-worms, which do not produce death, but which may produce very serious constitutional disturbance, and lay, at any rate, the beginnings of ill health. Then there are parasites which affect man in relation to climate, and which produce disease only under special conditions—such as that of tropical climate, for example. Such is the Guinea Worm, now and then seen in British hospitals, burrowing beneath the skin of the legs, and giving rise to painful swellings. But these latter considerations lie outside the main drift of my remarks to-night. For unquestionably it is those parasites that have the power of affecting us through our food, and through their being included in our dietary, which possess for us the highest importance.

In such a parasite as a "tape-worm," we may find a convenient starting point, because these parasites are unquestionably the most common visitants of the human territory. Let us firstly inquire, What is a tape-worm? In the answer to this question you will find a natural history study of, I hope, some little interest. The tape-worm has received its common name from its very obvious band or ribbon-like shape. In looking at it closely, we discover that all its parts are not of equal value or importance. Thus a tape-worm which may measure 20 feet in length, perhaps, possesses firstly a *head* (fig. 3, 1), which may not be larger than the head of a small pin. Immediately succeeding the head is a number of small joints forming the so-called *neck* (Fig. 3, 1 *d*) of the animal. Then succeeds the great bulk of the animal, composed of a series of *joints*. There are thus three elements in a full-grown tape-worm—*head*, *neck*, and *joints*. But when we think of a tape-worm, we almost insensibly glide into the idea that it must correspond to an ordinary worm, such as an earth-worm or a sea-worm. The naturalist, however, will speedily show cause for a change of ideas on this point. He will tell us that in considering the tape-worm we are regarding not one animal, but a veritable colony of animals—not a *single* individual, but a *compound* individual. Study for a moment how the tape-worm grows. The animal is ever increasing in length, and new joints are continually being produced from the neck extremity. The oldest joints are those which are furthest away from the head.

So long as the tape-worm head remains attached to the lining membrane of the alimentary canal of the animal it inhabits, so long it goes on producing joint after joint, and so long it adds largely to its increase and individual extent.

But let us now examine the constitution of a tape-worm "joint" (fig. 3, 2). The thin joint of a tape-worm is remarkable in one respect, namely, in that its whole interior seems to be occupied by an *ovary*, or egg-producing apparatus. We also note that each joint possesses an individuality of its own. The branched or tree-like structure you see in the centre of the joint (fig. 3, 2) is the ovary; and when you learn that each joint contains many thousands of eggs—or when you consider, in the light of that fact, that a tape-worm possesses hundreds of such joints—you can form some adequate conception of the enormous number of eggs which a single tape-worm is capable of producing. The tape-worm head is provided with a circlet of small hooks (*a*), which enable it to attach itself to the lining member of the intestine, whilst four suckers (*c*) also aid this attachment. Thus, we see in each joint of the tape-worm a semi-independent animal, and a distinct member of the elongated colony. Each joint is capable of producing perfect or fertilised eggs, and each egg can give origin to a new tape-worm, when the egg is placed under the requisite conditions for ensuring its development.

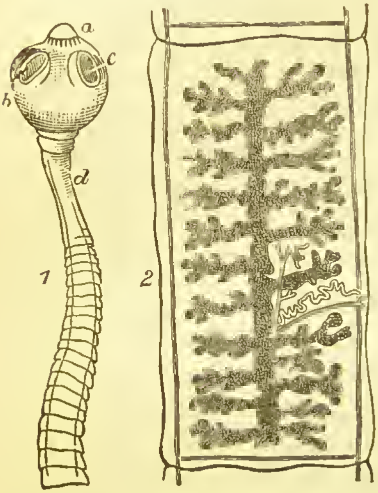

Fig. 3.

Anatomy of a Tapeworm.—1. The head and neck (largely magnified)—*a*, hooks; *b*, head; *c*, suckers; *d*, neck. 2. A single joint (*proglottis*), (magnified), showing the branched ovary and the generative pore or opening at the right-hand margin of the joint.

The development of the tape-worm becomes a subject of the highest importance, from a sanitary point of view. The eggs contained in the joints, escape from the body of man, and are distributed usually in sewage over the surface of the earth. It must be borne in mind that the egg of the tape-worm is a structure which, even before it leaves its "joint," or parent-structure, already contains within itself the young animal. The egg appears at this time as a small sac or bag, with a tolerably hard outside envelope, within which is the minute embryo, or young animal. The very earliest or primary steps of development have been undergone even while the egg was within the joint, and when the latter was within the body of its "host." Now, this egg requires to pass through a complex cycle of development; and we may at least gain one comfort in our study of the life-history of this parasite, namely, that the chances of destruction which await the young worm in the course of its development are so great, that in reality the tape-worm race is thus prevented from becoming a literally teeming population on the face of the earth.

We naturally divide the life of a tape-worm into two "epochs." The first epoch is passed within a different animal from that which harbours it in the mature state. The first host in the case of the common tape-worm (*tænia solium*) is the pig, and the second is the man. Suppose that the egg of a tape-worm is swallowed by a pig, the stages of its development are easy to trace. Development would then proceed, and would end by placing the worm before us at the end of its youth. If a man swallowed the egg of the common tape-worm, it would, as in the pig, simply end by becoming an imperfect worm. For the egg, to develop into a human tape-worm, requires to pass the first part of its history within a different "host" from that in which it attains its maturity; and the first "host" in this case, I repeat, is generally the pig. If, therefore, a pig swallows the tape-worm egg obtained from the digestive system of man, the gastric juice of the pig's stomach soon dissolves away the covering of the egg, and the small embryo is liberated. Under what guise does this young worm appear? As a "boring larva," or, as naturalists call it, the *proscolex*. Its name of "boring larva" indicates that it possesses a boring apparatus of hooks, and by aid of these hooks—not being permitted by the laws of its development to stay in the digestive system of the pig—it bores its way from the pig's stomach to take up its abode in the *flesh* or *muscles* of the animal. But even here, it cannot become a perfect animal or tape-worm. Within the pig's body, in short, it cannot advance beyond its youthful stage. Located in the muscles of the pig, it develops around its body a kind of bag or "cyst;" and, appearing in this guise, was known of old as a "cystic worm" or *scolex*, before its true nature was suspected. These young worms may be discovered as mere white specks in the flesh of the affected animal.

Here, then, the days of the tape-worm's youth may be said to end. If, as is extremely unlikely, the pig dies a natural death, and is respectably interred, there is an end at once to the pig's troubles and its aspiring tape-worm guests. But if, as is more likely, the pig passes into the hands of the butcher, the beginning of the tape-worm's adult stages looms in the distance. If a veterinary surgeon were to see the flesh of the infected pig at this stage, he would at once pronounce it to be unfit for human food, and he would in addition inform us that the pig had been attacked by "measles." "Measles," in this sense, is simply a name given to the symptoms produced in the pig and other animals by the boring inroads of the youthful tape-worms.

Now, if a piece of that pig's flesh should be eaten by a man the second part of the life-history of the tape-worm is immediately inaugurated. For, when the little cystic worm from the pig's flesh lodges in the human stomach or intestine, the bag or cyst falls away, and the little head and neck are alone left. But the head and neck contain, *in posse*, all the vitality necessary to produce the mature tape-worm. The head attaches itself to the lining membrane of the man's digestive system by its hooks and suckers. Thus located, the neck begins to produce its joints in the form of buds. The buds nearest the head, at first immature, soon acquire all the characters of well-developed "joints," as they are pushed further and further from the head. These joints develop the egg-producing apparatus, and other organs proper to adult tape-worm life. And thus, in due time, you find the budding tape-worm arriving at the stage from which we started—namely, at the adult or parent form, ready to send abroad its eggs, each of which is again capable of illustrating this marvellous cycle of development.

Thus, the life history of a tape-worm may be succinctly summed up by thus tabulating its stages :—

1st Epoch.	(1) The *Egg*, liberated from the human digestive system.	The Pig is the "Host."
	(2) The *Boring Larva* or *Proscolex* passing from the pig's stomach to its muscles to become—	
	(3) The *Scolex*, or *Cystic*, or *Bladder worm*.	
2d Epoch.	(4) The *Immature Tape-worm*, consisting of the head and neck of the *Scolex* eaten by man in the muscles of the pig, giving origin to—	The Man is the "Host."
	(5) The *Perfect Tape-worm* in man's intestine, produced from stage 4 by budding.	
	(6) The *Joints*, which are continually passing from man's intestine, and which contain, each thousands of eggs, leading us back to stage 1.	

Other tape-worms having an essentially similar history may be found within the human domain. The form we have just considered is the *tænia solium*, the first "host" of which, as we have seen, is the pig. But it so happens that we obtain from under-done beef the *tænia mediocanellata*, or the "beef tape-worm," as it is called. Naturalists call its immature stage the "beef-measle." This worm may attain a length of 30 feet, but, unlike the *tænia solium*, its head is utterly unarmed. If we study the life-history of this second tape-worm, which is obtained from under-done beef, it will be found to exhibit the same stages as the *tænia solium;* the only difference being that we should have to insert the ox as the first, and man as the second "host." But far more important is it to understand that this principle is carried out practically in all tape-worms—that is to say, that we never find any given tape-worm perfect in the same animal from which we obtain its early or "scolex" stage. Thus, the little cystic worm which exists in the liver of the rabbit, becomes, when eaten by the dog, a tape-worm of that animal. The little cystic worm or "scolex" of the rat and the mouse, becomes the tape-worm of the cat; and another curious cystic worm that inhabits the brain of the sheep becomes a special tape-worm (*tænia cœnurus*) of the dog.

But that a much more serious form of parasitic attack, in so far as the tape-worm race is concerned, awaits man, is disclosed by the history of another tape-worm *(Tænia echinococcus)* (fig. 4), which inhabits the intestinal canal of the dog. This is one of the smallest of the tape-worms, and seldom exceeds $\frac{1}{4}$ of an inch in length. It develops only some four joints, including the head (*a*), which has a double crown of very large hooks for attachment to the dog's digestive tract. Four suckers also exist for the same purpose. This small parasite, however, acquires a high importance in the human area, from the fact that man may become the *first* "host" in its development; just as the pig is the first "host" to his own tape-worm. Thus, if man swallows the egg of this tape-worm—obtained, say, from the surface of unwashed vegetables that have probably borne some relation to sewage manure—the egg passes, not to the muscle or flesh of man, whither we traced the egg of the *tænia solium* in the pig, but, as a rule, to man's liver. It rests in the liver, just as the "measle" of the pig rests in the flesh of that animal; and in the human liver this youthful tape-worm of the dog gives rise to an aggravated form of liver disease known under the name of *hydatids.* The liver in a bad case of hydatids exhibits a series of fluctuating tumours; and after death—for only too frequently the disease has a fatal ending—we may find the liver to be perfectly invaded by these cysts. The destructive nature of these young tape-worms in the liver is chiefly due to a peculiar characteristic of their development. The young forms of the common tape-worm in the muscles of the pig or ox are each of single nature. But each young *scolex* of this dog's tape-worm, when settled in man's liver, has the power of producing other cysts, or "heads and necks," in its interior by a process of budding. The parent, or first cyst or bag, may thus attain a very large size, and then appears as a large tumour in the liver, filled

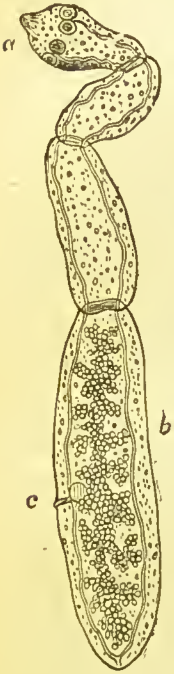

Fig 4.

Taenia echinococcus from the Dog. *a*, head; *b*, the last and mature joint; *c*, the generative pore (magnified after Cobbold).

with fluid, and containing within it "daughter cysts," as they are called, each of which, in turn, may contain many "heads and necks." Each of the latter, if swallowed by a dog, would of course give rise in that animal to the mature tape-worm.

A curious fact concerning tape-worms is found in connection with the history of the broad-headed tape-worm, or the *bothriocephalus latus.* This worm is never found native in England or Scotland; but it has been called the "Irish tape-worm," because it is indigenous in that country, where it may thus constitute a real "Irish grievance." It is certainly common in Western Switzerland and adjacent parts of France, and it also occurs in Geneva, and in Northern Russia and Sweden. This tape-worm is supposed by some authorities to pass its first stages of development within the bodies of certain fresh-water fishes of the salmon and trout kind; or, according to others, within the fresh-water fish known as the bleak. Some naturalists, on the other hand, maintain that this tape-worm may need no first "host" at all. We know that from its eggs, when placed in water, a little free boring embryo issues. But, as my friend Dr Cobbold remarks, the very presence of these hooks suggests that this young worm must naturally bore its way into the tissues of an animal, just as the youthful scolex burrows into the flesh of the pig. Be that as it may, the important fact to be borne in mind is this—that a fish-eating population is liable to incur infestation from these tape-worms, just as the flesh-eating population is liable to infestation from those to which I have already referred. A point of interest in the history of this "broad-headed" tape-worm is its size. It may have as many as 4000 joints, and may grow to be 25 feet long, and over an inch in breadth.

Before quitting the group of the "flat worms," let me remark in reference to the "hydatids" of the liver of which I have spoken, that this is a disease extremely prevalent in Iceland, owing to the immense number of dogs kept by the peasantry, and owing to the familiarity with which the canine population is there treated. An Icelandic peasant may often possess half a dozen dogs, which share his habitation, and it is obvious that the unnecessarily close relationship of the dog and his owner in such a case, gives opportunity for the passage of the germs of this parasite from the dog to the man. The high importance of sanitary precautions in the matter of dogs may be seen, when we learn that "almost the sixth part of all the inhabitants annually dying in Iceland" fall victims to the hydatid disease.

Last of all may be mentioned, in connection with the tape-worm group, the curious history of the *tænia cucumerina*, another species infesting the dog's intestine in its mature state. The eggs of this worm, passing from the intestine of the dog, are swallowed by the dog-louse infesting the animal's skin. In the louse, as a first "host," the worm attains its *scolex* stage, just as the young tape-worm of man attains that stage in the pig. The dog next swallows the louse in cleaning his skin; and thus introduced within the digestive system of the dog, the young tape-worm from the body of the louse, develops into its mature form within its canine host, whose body it has literally never left throughout its development. The "vicious cycle" of parasitism is plainly detailed in such a case as this, whilst Dean Swift's lines find here a highly practical illustration.

Passing now to the Liver Fluke (*Fasciola hepatica*), which, although not of much sanitary interest, may yet affect man, we discover in the fluke a parasite which kills thousands of sheep every year, by inducing the disease known as "rot." The fluke you may see for yourselves by procuring the liver of the sheep, and examining the bile ducts. It is a flat, oval body (fig. 5), about half an inch in length, provided with suckers for adhesion, and resembling in many respects the single joint of a tape-worm. Each fluke is capable of producing large numbers of fertilized or perfect eggs; but it is a

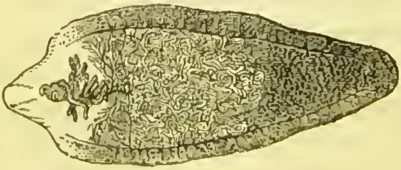

Fig. 5.

The Liver Fluke (*Fasciola hepatica.*)

[The "head" extremity exists at the left-hand side of the figure.]

single animal, and not like the tape-worm, a "colony" of forms. Occasionally the fluke may be found within the human domain. Surgeons and physicians have now and then put on record curious cases, in which this fluke has occasionally been found burrowing beneath the human skin and scalp. But these are rather rare occurrences. The only explanation which may be given of such cases is that which shows that in all probability man obtains the fluke exactly as the sheep obtains it, namely, from drinking impure water, and especially from water likely to contain pond snails, which may be said to play the part of intermediate "hosts" in fluke development. For the larva of the fluke swims at first freely in water, and it is possible that this larva may be taken into the body of man, as into the body of the sheep, in the act of drinking. A very serious disease, however, may be caused by an animal also occupying a place in the fluke-group. This is the Egyptian blood-fluke, or *Bilharzia*, so called after a physician practising in Egypt, and who discovered this parasite in 1851. It is a curious parasite, measuring about half an inch or little more in length. The female is larger than the male fluke. The bloodvessels of the kidneys appear to be the favourite haunt of this parasite, and the eggs appear to escape from the ulcerated surfaces arising from the irritation produced by the parasite.

Passing now from the "flat" worms to the group of the "round" worms, several of which find in the body of man a habitat, we may briefly note two species which are tolerably well known. For example, a very common human parasite, is the "common round worm" or *Ascaris*, which inhabits the human intestine, and may attain a length of from 4 to 6 inches. It causes ill-health probably from the constitutional irritation induced by its presence. Another parasitic worm is the "small thread worm" or *Oxyuris*, from which children are apt to suffer so persistently. These latter worms do not bear any special relation to food. The manner in which they are acquired, in other words, is not so important as a question of health as it is one of personal cleanliness. Infection is probably direct—that is, the eggs probably pass from the digestive system of an already infected subject to be swallowed by another person.

There are, however, other "round" worms which bring us within the spheres of the physician, since they may cause serious disease in man. Of these the Guinea-worm (*Dracunculus*) is an example. This form is supposed by very good authorities to have been the fiery serpents of the ancient Israelites. Plutarch, at any rate, has a reference to "worms" infesting people on the Red Sea, and taking up their abode in the legs and arms of the victims. In all probability the young of this worm enters the body in water. It is especially common in India, and its habitat is usually the lower limbs. The head of the worm is found at the top of a swelling, from which it is extracted by being slowly coiled round some object. The essence of this operation is to avoid breaking the worm, inasmuch as, through that accident the eggs, of which the worm is full, may escape into the tissues and cause fresh irritation. The Negroes of the Gold Coast are said to be specially dexterous in the removal of this parasite, the young of which, long believed to exist in the form of the tank-worms, common in India, are now proved to pass their early stages within water-fleas. By drinking water containing these "fleas," the young Guinea-worm is located within the human body, and burrows its way towards the skin-surface of man.

With the name of the *Trichina* every one must by this time be perfectly familiar. Not so long ago our newspapers chronicled the fact that questions were continually being asked in Parliament concerning the nature of American pork and butter, which were supposed to have been affected with this parasite. It is an evident fact that many of our legislators would have been none the worse for a little training in natural history, to have enabled them to satisfactorily determine the nature of this bugbear, the *trichina*, and of the disease which it produces, namely, *trichinosis*. The fact remains, at any rate, that a training in natural science is a valuable aid to a larger section of society than the world of zoologists and botanists. As a matter of deep social interest, the life-history of this animal is therefore of great importance, and, if I sketch it somewhat fully, it is because, of all parasites, it has perhaps the greatest interest for civilised man.

The *trichina* was discovered by Sir James Paget when dissecting as a student in St Bartholomew's Hospital in 1834, and in 1835 Professor Owen described and named it *trichina spiralis.* The latter name refers to the spiral fashion in which each *trichina* (fig. 6) lies coiled up within a small bag or cyst. As seen in the human muscle or flesh, these *trichinæ* appear as mere white specks. The average length of the male worm (fig. 7) is about the eighteenth part of an inch long; but the female (Fig. 8) is larger, being about the eighth of an inch long, whilst the capsule or cyst in which it is contained is about 178th part of an inch long, and the 130th part of an inch broad. The importance of a knowledge of the *trichina's*

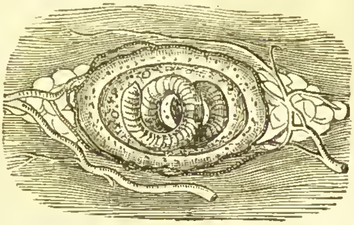

Fig. 6.
Immature or young *Trichina* coiled in its cyst in muscle (magnified).

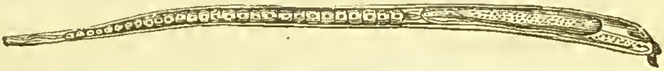

Fig. 7.
Mature Male *Trichina* (magnified).

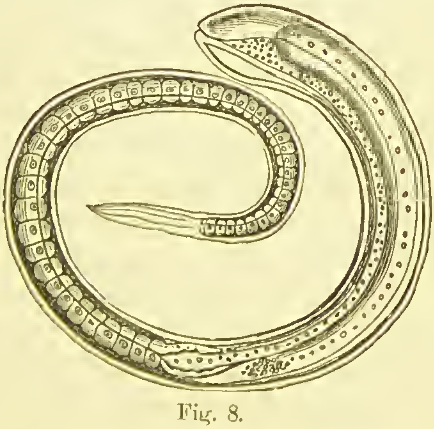

Fig. 8.
Imperfect Female *Trichina* removed from muscle, showing eggs in interior (magnified)

development consists in such information supplying us with the best safeguard against infection. The proverb that "knowledge is power" receives no more apt illustration indeed, than when applied to the case of parasites, and to the zoological history which shows how infestation may be avoided. The male *trichina* may be distinguished from the female worm by a forked appendage in which the tail terminates, but the body of the latter is stouter than that of the male. A very large portion of the interior of the body in the female worm (fig. 8) is occupied by the egg-producing apparatus, and here, as in the tape-worm, we have to note the extraordinary fertility of the parasite. I am certainly speaking within, rather than over, the limits when I say that each mother *trichina* is capable of producing, at the very least, from ten to fifteen thousand young. These young are further produced *viviparously;* that is to say, the eggs are hatched within the parent body, and the young pass from the parent ready to enter upon their further development.

A preliminary observation may be said to contain the key to the whole history of the trichina. It is this: that, as we find the trichina existing in the muscles of the pig (fig. 6), they are immature. In this stage, each trichina is incapable of producing young. Suppose, however, that a portion of the infected flesh is eaten by man, then, as in the case of the tape-worm, the trichina falls on its feet, as it were, and it rapidly advances towards the perfection of its kind. They are capable of living from four to five weeks within the human digestive system. But within the second day after they have been swallowed by man they may become perfectly matured; their reproductive energies are perfected, and then ensues a marvellously rapid increase of the race. Each mother-trichina within the human digestive system, is capable of producing her thousands of young; and if we consider that these parent trichinæ themselves may number perhaps hundreds or thousands, we may understand, in a new sense, the old sayings concerning the strength of united effort and the power of little things when multiplied to form their cohorts and legions.

What, then, is the next process that ensues? The horde of minute young now begins to migrate from the stomach to seek a resting place in the muscles or flesh of the individual. They resemble somewhat the youthful tape-worms in this respect. For this purpose the whole brood burrows its way from the stomach to the different muscles; and it is during this process of migration, and whilst the parasites are wandering from the stomach to the flesh, that the serious nature of the trichina-disease becomes apparent. For the patient then becomes afflicted with pains compared with which, the proverbial tortures that afflict the just are as nothing. The excruciating pains which attend the migration were amongst the first symptoms noticed in this disease. In a severe case of trichinosis, the disease goes on from bad to worse, and ultimately the patient's whole body becomes literally disintegrated, delirium ensues, and the patient dies in a state of extreme exhaustion.

But, in a case of milder type, the pain ceases whenever the young trichinæ has arrived at their home in the muscles. If the patient's strength can but hold out until the young trichinæ settle down in his flesh, he then may be said to be safe. There, each young trichina surrounds itself with a small cyst, such as we saw the parent (fig. 6) to possess; and no further development of these young can take place, unless, indeed, cannibal tendencies should be developed, when transmission of the young brood to the stomach of another individual would perfect them for reproduction, and would result in the development of a fresh generation of young. The last scene in the life-history of the trichina in man is extremely interesting. After the trichinæ have become encysted in the muscles for some months, each trichina exhibits a process of degeneration. It then becomes a mere speck of lime deposited in the muscular tissue. It is in this degenerated state that the trichina is most frequently met with in the human subject in the dissecting-room. How, it may be asked, does the pig get the trichinæ which inhabit its muscles, and which must have migrated from its digestive system, as their young will migrate in man? For the pig must have swallowed the parent trichinæ, and must also have suffered from the trichinæ disease. It is believed that the rat is the source from which the pig gets its trichinæ; and in all probability, the circle of development may be said to be completed by the rat in turn obtaining it somehow or other from man or from any other "host" of these parasites. As regards the number of trichinæ which may be contained within an animal, it is calculated that within a single ounce of flesh in an infected cat upwards of 325,000 parasites were contained. It has been calculated, also, that in an infected man, upwards of 40 millions of trichinæ may be present. Dr Cobbold tells us that in an ounce of pig's flesh 80,000 trichinæ were present; and he adds that the consumption of a pound of that flesh would give to man something like 400 millions of these "lodgers and boarders."

Our own country, happily, is almost entirely free from trichina disease. But on the continent, and especially in Germany, where the habit of eating uncooked pork or smoked pork is general, this disease is tolerably frequent. At first, indeed, the cause of this disease was so obscure that the cases gave rise even to ideas of poisoning; and it was only after the discovery of the trichina, and after the scientific investigation of its natural history, that the true nature of this disease was made known.

The time, however, has now come for a summary of the conclusions to which our studies naturally lead. I trust you have not been altogether horrified with these scientific details without at least some salutary effect following upon this process of laying bare the information and knowledge which usually remains in the possession of the naturalist and physician alone. I think I can sum up the health aspects of the subject in six axioms or pieces of useful information, the practical value of which I must leave to your own common sense to enforce.

Thus, firstly, we must insist upon all meat being thoroughly cooked, and the word "meat" ought to include fish. The reasons for these precautions follow upon your previous studies of to-night. First of all, from uncooked pork we obtain the pork tape-worm *(tænia solium)*, and from underdone meat, the beef tape-worm; whilst from uncooked fish, man may get the broad-headed tape-worm (or *bothriocephalus latus*), and from uncooked pork we may receive a deadly cargo of *trichinæ*. It is interesting to know that we can appeal to actual experiments by way of proving the accuracy of the advice which tells us that by means of thoroughly cooking our meat at a *high temperature* we may enjoy an absolute immunity from these parasites. A temperature of 140° F. has been estimated by the highest authorities to be that which no parasitic life can survive. If any one ate a piece of trichinised flesh—although it might, perhaps, be a rash experiment—which had been kept at this temperature for some length of time, he would in all probability escape the trichina infestation. Lesson the first is, therefore, one which advises us to cook our meat thoroughly, and to eschew a taste for underdone meat of all kinds.

Secondly, an equally important precaution is that of washing thoroughly all raw vegetable products. The reason for this piece of advice becomes clear when we reflect that we thus protect ourselves from the eggs of tape-worms, including the eggs of the dog's tape-worm which produces "hydatids" in the human liver. Even fruits, and especially such as have been picked up from the ground, without preparation may contain the germs of parasitic life. Raw vegetables of all sorts, such as lettuces and the like, used for making salads, for example, should be carefully washed to avoid danger.

In the third place, we should never drink water from any suspected or likely source of infection. By such sources I mean the water of canals and ponds, or of any brook which contains large quantities of vegetable matter, or which may harbour water fleas and water snails. From these latter animals we may obtain the young of certain tape-worms, and likewise the embryos of the liver fluke.

Fourthly, care must be taken of the general health. It is very important to remember in this connection, that parasites require a special soil for their growth, just as plants and animals at large require their special surroundings. And, therefore, other things being equal, these parasites are less likely to thrive in an individual whose general health is good, than in a subject of feeble constitution.

Fifthly, we ought to have—in so far as "hydatids" are concerned—special care of our dogs. Humanity to the dog is perfectly compatible with keeping the dog at a respectful distance. The Icelandic practice of living on equal terms with our canine friends, results in the continual presence of "hydatids." The dog is happy and man safer when the former is relegated to his proper sphere—that of man's friend, but not his bedfellow or co-tenant of his room and sharer of his cup and platter.

Sixth and lastly, the old view of the "sanctity of dirt" has certainly no application to the modern question of parasites. Strict attention to every detail of personal cleanliness, is at once the beginning and the end of the advice which shows us the way of escape from the subtle foes that everywhere environ our lives.

In bringing this discourse to a close, it may be well that I should refer to one or two points connected less with the sanitary aspects than with the scientific side of my subject. If I offer, by way of conclusion, a few remarks upon the purely scientific questions involved in the discussion of parasites and their history, you may be the better enabled to reflect upon the causes which have wrought out the singular relationship we have seen to exist between parasites and their hosts. I presume no reasonable person would dream of maintaining for a single moment that these hosts were created complete and perfect, with the parasites dwelling in their interior. Such an idea, if entertained at all, can only present itself as the legitimate outcome of an absurd theology, or of an equally childish and unreal conception of the constitution of living nature. Such an idea, moreover, is contrary to evidence of the most positive character, which assures us that parasitism, both as regards host and guest, is an acquired and not an original condition. It is the result of laws and conditions of life's development which are everywhere and at all times in operation around us—modifying universally the worlds of life, from the humble lichen to the stately pine—from the monad-speck, that hovers on the twilight of animal existence, to the occupant of the human estate himself. We can thus trace all degrees and gradations of the parasitic life, and we may follow it from cases in which there is mere association, to those in which lodgment alone is obtained within or upon the body of the host. We are led from these illustrations to examples in which the association has become of a closer kind; in which the parasite, originally free, has become wholly dependent on its host; and in which organs and parts useful for nourishment, for movement, and for other functions have grown "small by degrees and beautifully less," until the parasite appears as the degraded product of an acquired and secondary existence.

There are abundant examples and proofs to be found in the animal world of the originally free condition of the parasite. Think of *Sacculina* (fig. 1), the "guest" of the crab, which begins life as a free-swimming, six-legged water-flea, but which ends its life as the sausage-like bag whose roots, interwoven into the liver of its host, serve to feed its worse than vegetative existence. So also the life-history of a tape-worm and of a fluke equally present us with a notable clue to the original history of the parasite race, in the free condition of the young, and in the curious migrations through which these forms pass. If, therefore, the subject of parasites can teach you any lessons of wider application than mere sanitary cautions, valuable enough in themselves, I should say that you may be led from a study of the mere "why" of the subject towards some clear conceptions of a rational philosophy of the living beings—a philosophy which teaches that the ways of nature are everywhere hedged about with the conditions that produce continual change and variation in the children of life. As parasitism has been a growth and not a special creation, we may likewise discover that the cure and repression of this condition is really a matter of bettering our surroundings. As certain environments produce the soils and constitutions wherein parasites flourish and grow, so other environments check their growth and extirpate their race. The philosophy which teaches you the manner of their growth and development, likewise includes the knowledge on which to found their cure.

Last of all, in a day and in an hour when morbid sentimentalism fetters the hands of an unselfish science seeking but the advancement of truth, and the safety, welfare, and happiness of man, as well as the health of lower animals, you may be prepared to recognise that our immunity from the parasitic diseases that literally walk in darkness to slay us, is largely due to the just, legitimate, and reasonable sacrifice, in scientific investigation, of a few of our animal neighbours. You have heard of the fatality of certain parasitic diseases, and you will admit the desirability of saving the life of man and the lives of animals from such a fate. Yet I warn you that in making that admission you are taking the first step on a course which, if certain philosophers of both sexes are to be believed, will lead you to the antipodes of all morality and of religion itself. For the only means whereby we can discover at once the history of parasitic development, and the means of cure, consist in the sacrifice of animals to the artificially-induced parasitic disease. Over and over again, the most valuable results in the discovery of the where, whence, and how of dangerous parasites, have been obtained by the administration, to dogs and other animals, of the parasitic embryos. Our knowledge of the way of escape from the deadly "hydatids" of liver and elsewhere, and the knowledge which warns us against the fatal trichinosis, has been obtained in either case by the sacrifice of lower animals. Let me ask you who hold the power to make and to repeal laws in your hands, if the sacrifice of the lower to the higher life was not, and is not, more than justified in such a service? And when the hysterical wailing of a certain section of the public is heard in our courts and temples, lamenting the often theoretical pain to which lower existence has been subjected, you may perchance, with some echoes of this lecture ringing in your ears, reply, and reply boldly, that science has been more than justified in her unflinching pursuit of that saving knowledge, which, followed up through the pain and suffering of the lower form, rescues man from the confines of the dark valley and saves him from the "nameless terror" of his race.

THE BRAIN, AND ITS FUNCTIONS.

BY DR J. BATTY TUKE.

I HAVE but scant time for introductory remarks. When I arranged to deliver one of this course of lectures, I was duly warned by the excellent lady to whom we are mainly indebted for their institution, that my audience would be such as would not be content with the mere enunciation of dogma, that every statement would need to be substantiated, that to each commandment reasons must be annexed. And when I sat down to think seriously over what I was to say to you, I very soon discovered that were I to talk merely of what was good and what was bad for the brain, I should be only cataloguing facts and opinions, which you, in the abstract, were as well acquainted with as myself. This would have been easy to do, and we might have wiled away an hour in general talk. But I conceive it to be the object of this course of lectures to place before the public the fundamental facts and theories which influence the physician in his endeavours to prevent and to combat disease. These facts and theories are all based on the sciences of anatomy and physiology —the institutes of medicine. Starting on the assumption that you are entirely unacquainted with the anatomy of the brain, and that your knowledge of its functions is confined to a general abstract belief that it is the organ of the mind, I felt it would be only talking round the subject if I did not, in the first instance, present to you some of the leading facts connected with its structure and functions. This, then, is not to be, strictly speaking, a Health Lecture; it is to afford a basis for a discourse on Brain Health, which I hope to deliver to you on a future occasion, should what I lay before you to-night be found to possess such intrinsic interest as to induce you to return. I must beg your indulgence in dealing with a very large, intricate, and difficult subject; I can only hope to produce to you a very few of the most important facts. Had I to deliver six, instead of one lecture on the subject of the brain, my task would be comparatively easy—but if I can convey to you, within the next sixty or eighty minutes, some knowledge which you do not at present possess about this magnificent organ, my object will be gained.

Distributed throughout the whole system, pervading every tissue, except bone and gristle, there is a system of thread-like organs called nerves. In the skin and muscles, the nerves are in the form of small fibrils of a white colour. As we trace them upwards, we find these fibres coming together, forming bundles which grow larger and larger, as bundle joins bundle, until they form great nerve trunks, which pass into the spinal cord. The function of these nerves is to convey impressions *to* the spinal cord and the brain, and to convey from the brain and spinal cord the stimulus generated in those organs productive of motion. As I *must* circumscribe my subject it will be necessary to confine ourselves almost exclusively to this class of nerves, leaving almost unheeded the nerves of special sense, *i.e.*, those of the nose, eye, ear and tongue, and also to leave unmentioned those related to the great internal organs. Although we will thus be shut off from many questions of deep interest we will have little enough time to devote to the consideration of the connection of the spinal nerves with the brain and to the arrangement of the tissue of that organ and of the spinal cord.

The brain and spinal cord is composed of nerve fibre, nerve cells, connective tissue, and blood vessels. Their substance is a soft semi-fluid mass, the brain, for instance, contains 75 per cent. of water, only 25 per cent. being animal matter. In the spinal cord there is less water. The spinal cord is contained in the canal of the backbone; the brain in the great cavity of the skull called the *cranium*, or brain case. The spinal cord gives off for the supply of the trunk and extremities thirty-one pairs of nerves, which pass out by as many holes in the backbone, and those from the brain, with the exception of those going to the eyes and nose, emerge from the skull at its base by similar perforations. Notwithstanding these holes and the great hole for the passage of the spinal cord, the brain-case is hermetically sealed by muscles and other textures, so that no ordinary impulse from without can have any influence on its contents. Let me illustrate this. When I fill a glass jar with water, and inverting it under water, raise it above the surface, the water does not descend, the glass jar remains full; water may be forced out by the introduction of any body, but when that body is removed water returns. This represents the condition of the contents of the skull, which, whatever may be their difference in quality, must always remain the same in quantity. The bearings of this remark will be seen further on.

Each nerve is, as I have already said, composed of bundles of fibres, and each fibre is composed as follows,—first, internally, a delicate thread, called the *axis cylinder*, which is believed to be the medium through which impressions are conveyed to and from the nervous centres. This is surrounded by a white substance named, after its discoverer, the *white substance of Schwann;* and externally, a fine membrane of connective tissue, which is simply for the protection of the inner tissues.* Now, mark how closely the structure of a nerve resembles that of a submarine telegraph cable. A telegraph cable, as you see, is composed of a core, the copper wire which, as you know, conducts the magnetic current thus corresponds to the axis cylinder; second, a layer of gutta-percha, for the purpose of insulating the wire, that is to say, for preventing the access of any body which might divert the current,—this corresponds with the white substance of Schwann; and third, a parcelling of yarn for the purpose of protecting the gutta-percha,—this corresponds to the fibrous protective membrane. There is, however, a difference between the nerve fibres outside and those inside the back-bone and skull; the latter are not invested with the fine external fibrous membrane. They are protected by a connective tissue peculiar to the spinal cord and brain. This connective tissue, termed *Neuroglia,* or nerve-glue, is difficult to explain to a non-professional audience. It is an extremely delicate reticulated net-work of fibres pervading the whole organ. When I say you can figure it best to yourselves by supposing that this mass of tow represents a portion of brain connective tissue, (nerve-glue is a bad term, as it conveys the idea of an adhesive substance), and that these wires represent the nerve fibres, and these tubes the blood-vessels supported by it, you must remember that it is a tissue so fine and delicate that it can only be seen by the use of a very powerful microscope. I may best illustrate the coarseness of my illustration by saying that, were this tow and these wires a piece of an actual brain, the brain itself would be at least the size of the Castle rock. The nerve fibres of the brain and spinal cord are very delicate, varying in diameter from $\frac{1}{4000}$th to $\frac{1}{12000}$th of an inch, and, of course,are utterly inappreciable by the unassisted vision. There remains the nerve cells to be described—these are the most important organs of the nervous system; but I think it will be better to delay their consideration until I have described more fully the general anatomy of the brain and spinal cord.

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* Connective tissue is applied to the structures which simply bind together the component parts of the various organs, and serve as a support for delicate tissues.

The spinal cord is from fifteen to eighteen inches long; it is divided into two equal lateral halves by two fissures which nearly meet; it communicates with the brain through the great hole at the base of the skull. Throughout its whole length nerve fibres extend, but their arrangement is different in the front and the back portions of the organ. In the back portion of each half, or posterior columns as they are termed, as each nerve enters the cord a considerable number of its strands cross over to the opposite side and run upwards to the brain. The function of this part of the cord is to carry *to* the brain sensations generated in those parts in which the nerves are distributed, or to use the convenient scientific term, from the periphery. In the front, or anterior columns, the fibres pass upwards on the side they enter, and do not cross till they reach the medulla oblongata, the organ which connects the spinal cord with the brain. Their function is to carry messages *from* the brain to the periphery. The posterior or sensory nerves, and the anterior or motor nerves, are separate for some short distance after leaving the cord; but they then join and pass out from the back bone as one nerve, which has the power of transmitting messages upward and sending messages downwards.

I think I have said enough in the meantime about the anatomy of the nervous system to allow me to proceed to the description of the brain, which is its great dominant organ. The model I hold in my hand represents the organ exposed by removal of the skull—you see it looks as if enveloped by a bladder—this membrane is called the *dura mater* or tough protector; immediately below this is a very fine membrane called the *arachnoid*, its extreme delicacy suggesting a spider's web; and next to the brain itself is another fine membrane called the *pia mater* or soft protector, which invests it very intimately. All these membranes pass through the great hole at the base of the skull to envelop the spinal cord. This second model represents the brain divested of all its coverings except the internal one, and this third one a brain perfectly exposed. In this condition its average weight in man is nearly 3 lbs., in women some ounces less; this difference is not to be explained by the smaller stature and bulk of women, for it has been shown that whereas the brain weight is nearly 10 per cent. less in woman than in man, the stature is only 8 per cent. less. It was supposed by Sir William Hamilton and others that the brain reached its full development as to size at the age of seven, but this idea is now entirely abandoned, and it is generally held that it does not reach its maximum weight till the twentieth year. It is true that in boys it arrives at fully $\frac{5}{6}$ths of its weight by the seventh year, and in girls $\frac{11}{12}$ths, which may, to some extent, account for the greater precocity of the latter, but the change which goes on in its constituents during the development of the remaining $\frac{1}{6}$th and $\frac{1}{12}$th, between the years of seven and twenty, are of a most important character. I had intended to speak of the statements lately made in certain journals as to the alleged diminution in size of the head within the last fifty years, but the fallacy of those statements was so thoroughly exposed in last Monday's *Scotsman* that I deem it unnecessary to reiterate the arguments. I consider this article of so much importance that I purpose republishing it with this lecture.

The great anatomical divisions of the brain are not difficult to demonstrate. As I hold the model in my hand with its upper surface exposed to your view, you see a great mass of twisted and apparently irregularly arranged matter of a greyish pink colour, and when we examine the base of the organ we see the same type of arrangement existing there, except at the lower and back part of it, where we have a striped double mass. The upper twisted convoluted organ is the *cerebrum*—the great brain—*the* brain, and the inferior small striped organ is the *cerebellum* or little brain. You will notice a long mass projecting in front of the cerebellum, this is the *medulla oblongata* or oblong marrow (oblong in contradistinction to the long round spinal marrow); it is continuous with the spinal cord; and in front of it a transversely striped mass, called the *pons Varolii*, or Bridge of Varolius. I shall avoid technicalities as far as I am able, but for our mutual convenience I must ask you to remember the three terms—*cerebrum*, *cerebellum*, and *medulla oblongata*, and *pons Varolii.* When I remove the three latter organs you will see at a glance how thoroughly the great brain deserves its name; it is with this organ, the cerebrum, that I have mainly to do to-night.

The cerebrum is divided into two equal halves by a great fissure called the *great longitudinal* fissure; these halves are called the *hemispheres* of the brain. These are made up of apparently complicated structures, convoluted worm-like organs which twist and turn over its entire surface. But in point of fact the arrangement of these organs, which are called the *convolutions*, is pretty definite, and the anatomist has by careful study been able to arrange them into divisions or *lobes*, and to assign to each convolution a separate name. Moreover, the physiologist and pathologist have noted phenomena which point to different functions being localised in certain areas.

I will not go further at present into the nomenclature of the divisions of the brain than to state to you that the anatomist speaks of the *anterior*, the *middle*, the *posterior*, and the *tempero-sphenoidal* lobes.

The convolutions dip deeply into the substance of the organ;—this you cannot see in a model, but if you look at this brain which has been hardened in spirit, you will notice that they form deep furrows. On the depth of these furrows, and on the tortuosity and complexity of the convolutions is believed to depend, to a very great extent, the potentiality of high intellectual development; for in the brains of the inferior races of mankind the convolutions have been found very simple and shallow, whilst in those of distinguished men they have been generally observed deep and complex; and as we watch the scale of intelligence in the lower animals we find complexity of brain arrangement as we ascend. The purpose of the convolutions seems to be the extension of superficies on which to extend the more active structure of the brain, viz., the grey matter.

When we slice off a portion of the brain and expose its interior we notice a very distinct and definite difference in the appearance of its structure. There is a great central mass of a glistening white substance which is bordered all round by a layer of pinky grey matter which dips into the fissures and into all the furrows between the convolutions—it is about ½ an inch in thickness. The difference in colour between these two matters is due first to the much richer supply of blood to the grey than to the white matter; and second to the presence in the grey matter of those most important bodies the *brain cells.* Both matters are composed of blood vessels, neuroglia, and nerve fibre, but *nerve cells exist only in the grey matter.* These bodies which are found in incalculable numbers, probably in hundreds of thousands, vary in size, but the largest of them is invisible to the naked eye; they consist of finely granular protoplasm, *i.e.*, the simplest form of matter known to science; they vary somewhat in shape, those of the brain being mostly globular or pear shaped, appearing triangular when cut through lengthwise; those in the spinal cord being irregular in shape, presenting this appearance under the microscope (fig. 1). Each contains a *nucleus* or kernel, which again contains a *nucleolus* or little kernel. They are arranged in layers of from four to six in number and are supported in position by the neuroglia. I have twice used the adjective "most important" when speaking of these bodies; and, for this reason, we have the best reasons for believing that they are the organs through which impressions from without are appreciated, that through their vital properties we see, taste, hear, smell, and feel, and that in them is generated and stored up what we, in our ignorance, term nerve force, and from them is discharged what we, in our ignorance, term nerve energy. For the purpose of immediate illustration let me adduce three experiments in confirmation of these statements—(1) When we irritate the surface of the skin a sensation of pain is produced which is referred to the part injured, but which really exists in the brain; for if we cut off the nerve connection between the part and the brain no sensation is experienced however much the part may be irritated. The brain is therefore a perceptive centre; (2) When we will to move a limb, under ordinary circumstances the limb obeys the stimulus of the will and movement ensues; but if we destroy any part of the nervous apparatus connecting the brain and the limb, no effort of will can produce action. The brain is therefore the organ of volition. In the first instance the results of irritation cannot be carried *up* to the brain, and in the second the stimulus of the will cannot be carried *down* to the limb; (3) When the grey matter of the convolutions is removed or injured by extensive disease the subject of experiment becomes more and more dull and stupid until at last all indications of perception and volition disappear. Comparing it to an electric telegraph whose apparatus is at fault in the first experiment

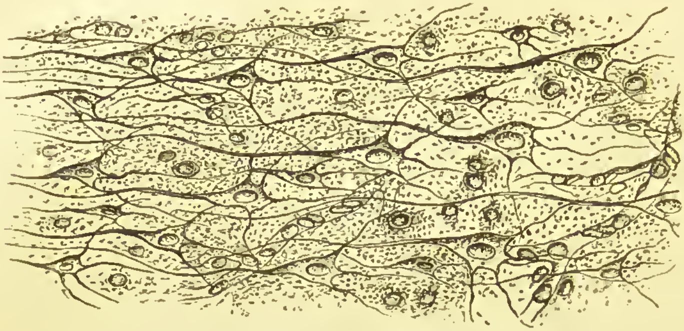


Fig. 1.

the indicating needle is useless; in the second the manipulator may work the handles as energetically as he will, but without result, in both instances because the connecting wires are injured; and in the third experiment the cells of the battery are removed.

Let us now inquire what is the arrangement of the connecting apparatus. As I have shown you, each hemisphere of the brain consists of masses of grey matter and of masses of white matter. The grey matter is arranged in *ganglia, i.e.*, aggregations of nerve matter containing nerve cells. These ganglia are two-fold—1st, the grey matter of the convolutions forms two great ganglia called the *great hemispherical ganglia*, covering the whole surface of the organ, and 2nd, in the middle of the brain or rather nearer its base there is a series of such ganglia. The scientific terms applied to these are *optic-thalami* and *corpora striata;* but I shall speak of them as the *basal ganglia.* The grey matter of these basal ganglia is in direct anatomical connection with the grey matter of the spinal cord, which differs from that of the cerebrum in that it lies in the centre surrounded by white matter. In the spinal cord the white matter is external. We have already traced the course of the fibres in the cord. Remembering that the function of the anterior fibres is downward and that of the posterior upward, we will, for the purposes of anatomical description, trace them from below upwards. In their course to the brain they are connected with the cells of the grey matter of the cord—passing through the medulla oblongata, and pons Varolii, they run towards the basal ganglia, some of them passing right through, whilst others terminate in the great nerve cells of those organs, and are thus interrupted in their continuity; but they start afresh to pass on with the uninterrupted fibres in their course to the grey matter of the hemispheres. From the basal ganglia the fibres spread out like a fountain, or like the sparks from a firework—they radiate, or are projected towards the dome of grey matter, and are in consequence termed the *corona radiata*—the radiated crown, the *projection series* of fibres. By this means we have direct communication established between the furthest extremities of a nerve and the hemispherical ganglia. An ounce of demonstration is worth a pound of description in dealing with such a difficult subject, and I do not think I would have ventured to speak about it were it not that I had it in my power to lay the actual thing before your eyes. This I am enabled to do by the kindness of Dr Hamilton, Pathologist to our Royal Infirmary. This large slide contains a very thin section or slice of a human brain. By a marvellously ingenious process devised by himself, Dr Hamilton is able to cut a slice so thin as to permit of the passage of light, and therefore to cast on a screen the images of its various structures. What I am about to show you is a slice made through the entire substance of the organ as nearly as possible in the middle line from before backwards.

[Here a longitudinal vertical section of the brain was thrown on a screen 20 feet square, showing in detail what is seen in diagram No. 2.]

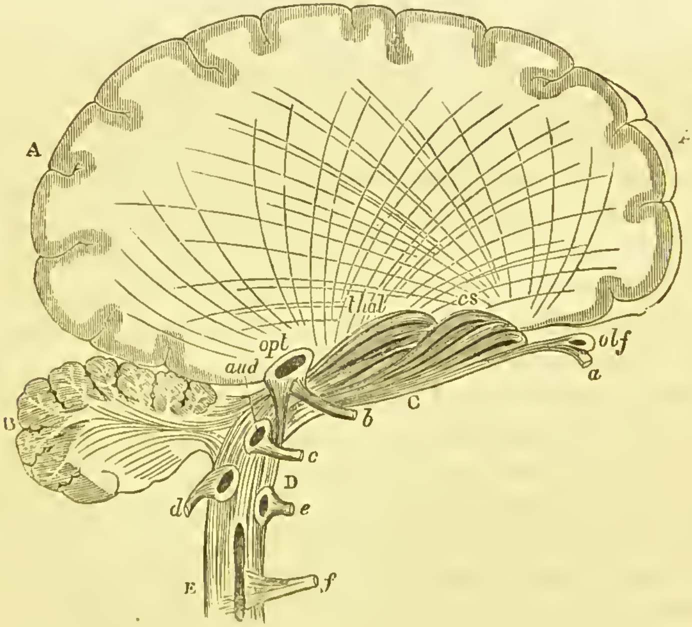


Fig. 2.

But you will ask how does fibre communicate with cell. Looking at this model of a cell we see that it has various filaments projecting from it; these are called the *Poles.* Cells are termed *unipolar, bipolar,* and *multipolar,* according as they possess one or two or many projections (see fig. 1). The poles at the base are termed *basal,* those at the apex *apical,* and those starting from the sides *protoplasmic.* Now the basal pole is continuous with the axis cylinder of the nerve fibre, which I told you is the medium through which impressions are conveyed in the nerves. According to certain authorities the poles at the apex are continuous with a horizontal series of fibres on the surface of the convolutions, and it is also believed that cell communicates with cell by means of the protoplasmic poles.

So much for the connection of the brain with the rest of the nervous system; but we must revert to the models again for a few minutes to show another important connection, that between the two hemispheres. Every part of the nervous system is double: there is a right and left cerebrum, cerebellum, medulla oblongata, and spinal cord, and each of these lateral halves is in direct communication with the other. The nervous centres are double organs, and are associated together by nerve-fibres. I ask you to accept this statement as far as it concerns the other organs, but I am able to demonstrate it to you in the case of the brain by another of Dr Hamilton's wonderful sections. Deep as the great longitudinal fissure is, it does not cut the cerebrum entirely in two. At the bottom of the cleft there is a mass of transverse fibres called the *corpus callosum,* or hard body. This is the most important commissure of the brain. The derivation of the word commissure, *committo,* to bring together, indicates its function. Through it pass nerve-fibres which can be traced from the grey matter of each hemisphere, bending in the form of an arch (and therefore termed *arcuate* fibres), to the corpus callosum, passing through which, they course to the grey matter of the hemisphere opposite to that they start from, and reach it at an exactly corresponding spot—identical portions of each hemisphere are thus connected.

(Here a transverse vertical section was shown, illustrated by diagram No. 3).

Thus we have, by means of nerve-fibre, a perfect system of association—by the radiating fibres the spinal cord is in direct connection with the cells of the grey matter of the brain, and by the arcuate system the cells of opposite hemispheres are brought into intimate relation one with the other.

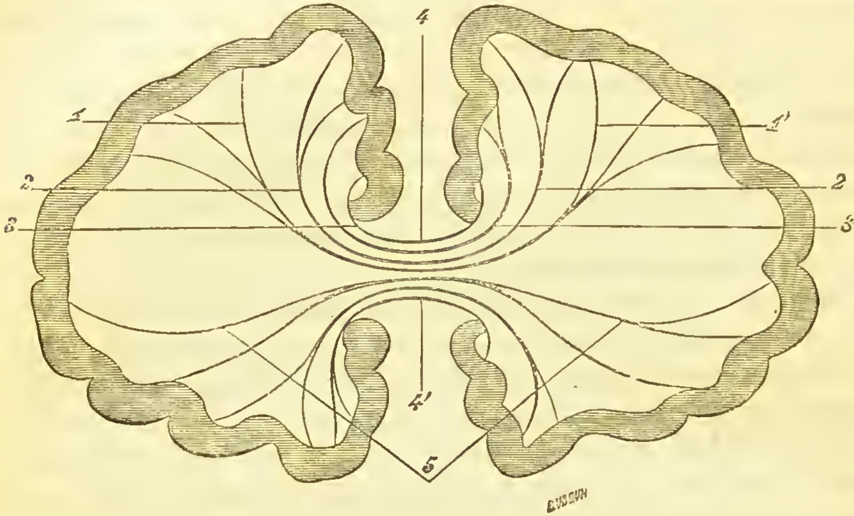


Fig. 3.

I will now direct your attention to the blood-supply of the brain. From its constant activity, the brain demands a large amount of blood to nourish and restore its elements. In point of fact, nearly 6 per cent. of the total blood is at work in the brain: and if we consider that about 64 per cent. of the blood is circulating in the heart and large vessels, and only some 36 per cent. in the tissues of the body, we gain an idea of how richly the brain is supplied. Time will not permit of me going into the interesting subject of the arrangement of the brain blood-vessels. Suffice it to say that it is devised with the objects first of insuring not only a very copious supply, but also a very uniform and equal flow of the nutrient fluid, and secondly, of protecting it, as far as possible, from influences from without. The results of the stoppage of a cerebral vessel are most disastrous—the functions of the part supplied are at once arrested, and unless the obstruction is removed the tissues become permanently disorganised. The convolutions are nourished by vessels which enter from their outer surface, certain of which pass on to the white matter. But the blood-supply is five times greater to the grey than to the white matter, an additional evidence, if such were necessary, that the former exercises much more functional activity than the latter.

You will remember that I pointed out to you at the opening of this lecture that the brain is contained in a hermetically sealed cavity of rigid bone, and that the quantity of matter in this cavity must always remain the same. Now, unless some provision exists for differences in the amount of blood in the brain, it follows the amount of blood must remain invariably uniform. And this was for long believed to be the case. But experiments have shown that this is not true, that, although the total amount is pretty uniform, still, under certain circumstances, the quantity of blood varies. This is markedly so in the condition of sleep—it has been reduced to demonstration that during sleep the amount of blood in the brain is diminished. How, then, is compensation procured for the withdrawal of blood, and what material is displaced if a greater quantity than usual is introduced? This compensation is procured by the *cerebro-spinal fluid.* You know the brain contains 75 per cent. of water: under circumstances of blood-pressure, a certain portion of this water becomes rapidly absorbed or displaced, and when blood is withdrawn a portion corresponding in bulk to the abstracted blood is rapidly drawn into the cavity of the skull. "Hence we may consider that the cerebro-spinal fluid in the interior of the skull not only subserves the mechanical functions of fat in other parts as a packing material, but, by the readiness with which it can be displaced, provides the means whereby undue pressure and insufficient supply of blood are equally prevented" (Kirke's Hand-Book of Physiology).

The consideration of the chemistry of the brain will not detain us long, for really not very much is known about it. The nervous tissue contains substances closely allied to albumen, which, as you know, is the chief constituent of the white of egg, a substance which coagulates when mixed with alcohol. But I do not think any physiologist would venture the statement made by a distinguished teetotal lecturer last year in this city, that these albumenous substances contained in the brain become coagulated by the drinking of spirits. Were it true that when alcohol is introduced into the system the albumen of the brain coagulates, the brains of a very large proportion of our countrymen would be in a condition identical with that of hard-boiled eggs; and although the Scot is generally regarded as a hard-headed man, his hard-headedness hardly amounts to this. The lecturer I allude to reduced his statement to demonstration. He placed in a glass vessel a certain quantity of white of egg, which he told his audience was identical with certain substances contained in the brain. He then poured in a glass of whisky which, of course, produced coagulation, and he drew the deduction that the same result obtained in the brain when it was under the influence of alcohol introduced into the system through the stomach. It is a pity that a good cause should be marred by such misrepresentation. Supposing I were an anti-teetotal lecturer, I could equally easily, and equally inaccurately, quote chemistry for my purpose in denouncing tea. I should say to you:—"Ladies and Gentlemen,—Dr Foulis in his lecture last year on the blood told you that it contained a considerable amount of iron. You are in the habit of thinking tea is a harmless beverage, but mark this experiment:—In this jar of water is a small quantity of a solution of iron. Observe the dreadful results when I add to it a cup of tea —it converts it into ink by virtue of its tannin, and it acts in a similar manner on the blood!" I beg to assure you, however, that both statements are equally incorrect. Alcohol does not harden the brain, on the contrary, it softens it; and tea does not convert the blood into ink. I wonder if this lecturer would be surprised to learn that, do what we will, a true alcohol exists in every brain. In the nervous tissues of the most conscientious teetotaler an alcohol called *cholesterin* is to be discovered in considerable quantity. He would probably say that if such is the case there is no reason for adding more, and, unless under exceptional circumstances, I am inclined to agree with him.

With this very rough statement of the anatomy and structure of the brain, we pass on to consider its functions. Certain of these have been already alluded to. I am only going to speak of the functions of the cerebrum, leaving those of the cerebellum and the medulla oblongata either to another occasion or to another lecturer. The functions of the cerebrum are thus summarised by Kirke:—"(1.) The cerebral hemispheres are the organs by which are perceived those clear and more impressive sensations which can be retained, and regarding which we can judge. (2.) The cerebrum is the organ of the will, in so far at least as each act of the will requires a deliberate, however quick, determination. (3.) It is the means of retaining impressions of sensible things, and reproducing them in subjective sensations and ideas. (4.) It is the medium of all the higher emotions and feelings, and of the faculties of judgment, understanding, memory, reflection, induction, imagination, and the like."—("Handbook of Physiology," Kirke.) These conclusions have been arrived at (1.) by the observation of the facts of comparative anatomy, which show that as we ascend in the scale of the animal kingdom, with increased development of the brain we have an increase of intelligence, till on reaching man we find the most perfect type of brain; (2.) by the careful study of the symptoms of disease of the brain; and (3.) by experimentation. The subject of progressive development is most interesting, but I cannot allude to it further now than to point out the characteristic of the human brain which serves to distinguish it from those of the rest of the animal kingdom. This is that in it only the posterior lobes are so fully developed as to overlap the cerebellum. Even in the higher apes in which the type approaches most nearly to that of man, the back part of the brain is much less perfectly formed, and the cerebellum can be seen when the organ is viewed from above.

But the most definite proof that the cerebral hemispheres are necessary for the production of those phenomena which we term intelligence and will, is based on data procured by the observation of their injury by disease, or by the hand of the physiologist. Every one knows that a violent blow on the head produces unconsciousness, and that mental function is in abeyance when blood is effused on to or into the brain, producing apoplexy. But these are but coarse experiments, and the physiologist has been obliged in order to elucidate important facts bearing on the treatment of disease to submit animals to experiment. He has found by this method that when the grey matter of the superior convolutions is removed, intelligence and voluntary movement are put an end to—that all spontaneous action becomes impossible. A frog, the upper part of whose brain has been removed, continues to breathe, and is even able to move his limbs when irritation is applied to them, through virtue of the functions of the spinal cord and medulla oblongata, which are themselves independent nervous centres—independent to this extent that they are able to transfer impressions from the posterior or sensory columns to the anterior or motor columns, without sensation being conveyed upwards to the brain, and yet motion being produced. This is termed *reflex action.* But as I have already stated to you, if the grey matter of the convolutions is destroyed, or if the connection between the brain and the spinal cord is severed, feeling cannot be experienced and the will becomes inoperative. I do not think it necessary to prolong the argument, as sufficient has been said to enable you to give a reason for your belief, that the possession of a brain is necessary for the manifestation of mental phenomena—that it is in fact the organ of the mind. What the nature of the processes is through which these phenomena are produced we are entirely ignorant. As Hermann says, "in a part of the central organs, the cerebral convolutions, certain material processes are accompanied in an inexplicable manner with wholly indefinable phenomena, which characterise what we term consciousness. The term mind may be applied to the combination of all the actual and possible states of the organism."

Nothing is definitely known as to whether any of the mental functions are localized in any particular part of the brain. It is highly probable that such is the case; but science has not as yet been able to produce any substantial proof. You may feel quite certain, however, that the so-called science of phrenology is based on entirely fallacious data. The idea that the skull can be mapped out into small areas indicating the mental function of the subjacent brain, is entirely false. If we look at a brain covered by its tough outer membrane we see that it is as devoid of irregularities on its surface as a bladder of lard; and if again we inspect the inner surface of the skull cap we find that if it has any depressions they do not correspond with elevations on its outer table. The phrenological images which are still sold in the shops may be regarded as the Fetishes of an extinct faith. I wish I had time to tell you of the work which is being done by many earnest physiologists, who are striving hard to arrive at accurate conclusions as to the localisation of brain functions. It is a question of the utmost importance to medicine, and already many valuable observations have been made; but so long as the physiologist has his hands tied by legal enactments the interests of the healing art must suffer and mankind with them. Let me remind you of what was once said by the highest authority in morals—"Ye are of more value than many sparrows."

I will only instance one or two of the results obtained in this direction. Fritsch and Hitzig in Germany, and Professor Ferrier in this country, have found that the stimulation of various circumscribed areas on the surface of the convolutions (which till lately was believed to be insensible to irritation) is followed uniformly by movements of particular limbs,—for instance, if a mild current of electricity is applied to one spot, the leg is moved; if to another, the eyes; if to a third, the neck, muscles of the face, and so on. Ferrier, indeed, has by patient inquiry mapped out the various areas which he holds to be centres from which, in the phenomena of voluntary movements, influences pass to special groups of muscles; and he has continued his investigations in the direction of destroying these centres, and has found that paralysis of the muscles which contract on the irritation of electricity, is the result. I admit that this line of investigation was first suggested by the observation of disease. Broca of Paris noted the uniform coincidence of destruction of a small area of the anterior convolution of the left side with loss of speech; but this observation merely opened up a field of inquiry most important in its relation to medicine and physiological science, which could not have been tilled if the physiologist had not submitted animals to experimentation, nor, in fact, could any of the physiological facts I have adduced to you to-night have been verified or reduced to demonstration without vivisection.

In conclusion, allow me a few minutes to indicate the practical outcome of this lecture. Having now before you some of the great facts connected with the constitution and arrangement of the tissues of the brain as they exist in health, it will be all the more easy for you and for me to consider together on a future occasion the effects produced upon them by malign influences. My hope is that the demonstrations of to-night will help you to recognise the truth of the theorem, *that we have a right to presuppose that in the brain, as in other organs of the body, the normal exercise of function is dependent on a perfect maintenance of the anatomical relations of the component structures.* Believe me, this position is not by any means universally accepted; the world is only too apt to regard many of the phenomena of brain disease as mere perversions of function, independent of structural change: few men, for instance, appreciate that that most awful calamity, madness, is dependent on material morbid processes—that it is a disease. Lunacy is regarded more as a psychological curiosity than as an indication of a diseased condition. I expect to be able to demonstrate to you the structural nature of many of the morbid conditions which are produced by certain of our habits of life; and when I address you on the subject of Brain Health I shall feel something under my feet when speaking of the evil effects of neglected or of over education, of over work or of idleness, of alcoholism, of over and of under feeding—"Brain cell," "nerve fibre," "neuralgia" will not be mere terms, but will convey to your minds something palpable; you will know that they are structures which may be put out of gear just as any other structure of the body may be; "nerve exhaustion" will not be a mere form of speech. There is perhaps no organ of the body over which we can of our own free will and accord exercise so much influence for good or for evil as the brain; we can to a great extent make it or mar it, and in marring it we mar the whole system, *for on the normal exercise of brain function depends the permanent exercise of the function of every structure of the body.* And remember this—the brain cannot, like the lungs, the liver, the skin, or the kidneys, cast any of its functions on other organs—it is, so to speak, self-contained—it can gain no relief in disease from vicarious aid; it must do its own work, rid itself of its effete matter and of the products of injury or disease, and provide within itself for the resumption of functions, the exercise of which has become impaired from whatever cause.

We see daily the evil effects of overstraining the powers of the brain. Many sources of overstrain are beyond our control. In the hard battle of life man must work hard to gain a living, and often under circumstances prejudicial to brain health. But mind you the brain is a long suffering organ as far as work is concerned. It is not work but worry that kills it, and worry is not an influence we can often keep in subjection. But it is in the power of many members of the community to kill the brains of others by overstrain. It is very doubtful economy to overstrain thews and muscles, it is very false economy to overstrain brain cells, for on the action of these cells the proper use of the muscles depends. When a man has to concentrate his attention his brain cells are actively at work—work implies loss of tissue and constantly diminishing functional activity; therefore concentration of attention is limited. This is practically admitted in certain services —*e.g.*, the naval and military—in the former, a man's trick at the wheel does not exceed two hours, and in the latter the sentry holds his post for the same term. Except in time of war it does not very much matter about the soldier, but the sailor at the helm may, by a mistake, cause loss of life and property. Experience has thus demonstrated the physiological fact that, even under supervision of trained officers, human attention cannot, under ordinary circumstances, be relied on for more than a certain limited time when the safety of communities is at stake. But we are told this is disregarded in the service which most of all holds men's lives in its hands—the railway service. We are told that railway servants are kept in the switch-cabin for many long hours at a stretch, wielding the instruments, the wrong use of one of which may wreck the train. This is an utterly unphysiological position in which to place any man, and the onus of evil consequences lies at the door of those who outrage the laws which govern health. No individual or company can protect himself or themselves against the stupidity of mankind; but given a proved attentive servant who has to exercise monotonous duties on the accurate performance of which the safety of the public depends—given in fact the very best conditions—it is worse than unwise to press his powers of concentration for more than a very few hours at a stretch. Railway servants should keep watch and watch; their trick at the switch, like that of the sailor at the wheel, should be two hours about. If under such circumstances he fails in his duty and kills men he may be held responsible—but not otherwise.

I wish you all good night, trusting that within the next two hours the supply of blood to your brains may be diminished, and that sleep will ensue in accordance with physiological laws, and that you will all rise strengthened by repose and ready to receive the health-giving influence of the God-ordained day of rest.

HEAD MEASUREMENTS.

The Scotsman, December 5, 1881.

The brain is universally recognised as the organ of mind, and the size of this organ is very generally taken as an index of mental capacity. Big brains have come to be suggestive of great minds, while it is an undoubted fact that the possession of a brain which falls below a certain minimum standard of weight implies idiocy on the part of its unfortunate possessor. M. Broca places the lowest limit of brain-weight compatible with human intelligence at 37 oz. in males, and 32 in females, the average brain-weight of Europeans being about 49 oz. Whether the possession of more than the average quantity of brain implies the presence of more than average intelligence is a question that has given rise to much discussion. It is an undoubted fact that very high brain-weights are occasionally found in people whose mental acquirements are certainly not above the average. Out of 157 brain-weights of adult Scotsmen, Dr Peacock found that four, all belonging to artisans, who, so far as could be learned, had not been distinguished above their fellows by superior intellectual endowment, weighed over 60 oz. each, while the heaviest brain on record—it weighed 67 oz.—belonged to a bricklayer. Dr Morris, who chronicled the case, was told that the man "had a good memory, and was fond of politics; but that he could neither read nor write." Whatever his potentialities might have been, "it is evident," says Dr Morris, "that his actual acquirements were not great." The non-development of superior mental power in such cases may, however, be attributable not to lack of capacity for learning, but to the absence of the conditions necessary to its growth. Certain it is, that among the educated and intelligent classes the number of big brains is greater than with uneducated and less intelligent people. Among the latter, the proportion of brain-weights above 55 oz. has been ascertained to be only from 4 to 6 per cent, while the proportion among men who have been distinguished for great intellectual acquirement is at least 23 per cent. The brain-weights of only 23 such men are accurately known, and it is from these that the above proportion has been obtained. With few exceptions, these were all above the average capacity of 49 oz. First in this respect comes the celebrated naturalist Cuvier, with a brain-weight of 64½ oz., followed by the famous Scottish physician, Abercromby, and the poet Schiller, each with 63. Goodsir, the anatomist, follows at a considerable distance with 57½, Sir James Simpson with 54, and Chalmers with 53. That such men as Gladstone, Bright, etc., possess more than average brain-weight may be inferred from a statement lately made public of the size of hat worn by these and a number of other living or recently deceased statesmen and litterateurs. Premising that what is known to the trade as size 7 is that of the average head, with presumably 49 oz. of brain, and that 7⅜ is a size so large as only to be made when specially ordered, it appears that out of fourteen persons whose hat-sizes are given, two (Lord Chelmsford and Dean Stanley) were below, while other two (Lord Beaconsfield and the Prince of Wales) were exactly up to the average. Of the others, Dickens, Selborne, and Bright required 7⅛, Earl Russell 7¼; Lord Macaulay, Gladstone, and Thackeray, 7⅜; Louis Philippe, 7¾; and the Archbishop of York, 8 full! Of the twenty-three distinguished men already referred to whose actual brain-weights are known, four, including the late Professor Hughes Bennet, and Hermann, the philologist, were distinctly below the average, showing, as Dr Bastian points out in a recent work, that "a well-constituted brain of small dimensions may be capable of doing much better work than many a larger organ whose internal constitution is, from one cause or other, defective." When there is no such defect, however, the big brain, there is every reason to believe, confers an undoubted advantage on its owner.

Such being the case, it is not surprising that the assertion recently made, that a sensible diminution had taken place of late years in the size of the heads of the male population of those islands, and consequently of the brains—for in health the brain always fills the skull—should have attracted attention. The data upon which this startling statement is founded have been supplied by the most persistent, if not the most scientific, class of head measurers—the hatters, whose evidence on the point is of the most circumstantial kind. One merchant, of large experience, states that of the six sizes of hats beginning at 21 inches, and increasing by one-half inch to 23½ inches, he was in the habit, five-and-thirty years ago, of buying for his retail trade in the following ratio, beginning at 21 inches—viz., 0, 1, 2, 4, 3, 1, while at the present time he is selling hats in the following ratio—viz., 3, 4, 3, 1, 1, 0. In other words, where only one hat was required, thirty-five years ago, at or under 21½ inches he now requires seven; and where formerly four of the two largest sizes were required, he now only needs one. From numerous letters which have appeared in *Nature*, the experience in this instance would appear to be that of the trade generally. One manufacturer writes—"I should say that heads generally are two sizes less than at the time (thirty to forty years ago) you refer to; a head of more than 24 inches circumference is now quite a rarity, whilst we make thousands of hats for heads with a circumference of about 21 inches." The decrease, according to another manufacturer, is so general "that we do not make big-sized hats for stock, but only as ordered, and very few then." That a similar diminution has taken place in Scotland is the experience of one of the principal hatters in Glasgow. There can be no reasonable doubt, therefore, that our hats are, on the whole, smaller than they were a generation ago; do smaller hats, however, in this case imply diminished heads? It has been pointed out that the undoubted diminution is probably to be explained by a reference to change of fashion in the mode of wearing both hat and hair. Thirty years ago it was customary, as the prints of the time show, to wear the hat drawn well down over the head; how far over may be judged from the fact that it was customary, in England at least, to attach a piece of cloth to the under side of the brim at the back in order to take the friction off the coat-collar. On the other hand, the hair was worn thick and long, the present style of close-cropped hair being in those days associated with soldiers and prisoners. These two causes together seem fairly adequate to explain such decrease in the size of hats as has been noticed. If inadequate, as certain correspondents in *Nature* maintain, the only alternative is to believe that, in the course of little more than a quarter of a century, the heads, and consequently the brains, of our male population have sensibly diminished. That this is in the last degree improbable will be the opinion of every student of recent anthropological science.

In a progressive civilisation such as prevails in this country and throughout the greater part of Europe and America, there is reason to believe that the cranial capacity of the population is, on the whole, increasing rather than diminishing. Owing to the want of early observation, it is difficult to institute comparisons between past and present. An opportunity, however, lately occurred in Paris which was taken advantage of by M. Broca. In digging the foundation of a new building a vault was opened containing a large number of human skeletons, whose surroundings proved them to have lived not later than the twelfth century. M. Broca found the average capacity of 115 of those twelfth century skulls to be 1426 cubic centimeters; while another series of skulls—125 in number—taken from a cemetery belonging to the early years of the present century, gave an average of 36 cubic centimeters more. The average Parisian skull would thus seem to have increased considerably in capacity during seven centuries of progressive civilisation. That this increase has gone on slowly but surely as man progressed from barbarism to civilisation may be inferred from a study of the cranial capacities of the various human races. Thus, while the brain capacity of the European amounts to 94 cubic inches, it is only 91 in the Esquimaux, 85 in the negro, 82 in the Australian, and 77 in the Bushman. These are merely averages, and, as such, do not bring out the important fact lately noticed by Le Bon, that among the lower races the limits of variation in the cranial capacity of individuals of the same sex are much less extended than in the higher races. Thus, among modern Parisians large and small skulls vary by about 600 cubic centimeters, while negro skulls vary only by 204, and ancient Egyptian by 353 cubic centimeters. Another important difference in the cranial capacity of the higher and lower races is connected with sex, and serves to throw light upon the influence of mental exercise in increasing brain capacity. According to Professor Bischoff, of Munich, in a recently-published work, the difference between the average brain-weight of men and women is 10½ per cent. Much of this is undoubtedly due to difference in stature, a tall person having, *cæteris paribus*, a larger brain than one less in height; partly, however, it is attributable, there can be little doubt, to inferior mental training. Among the lower races, where the women have not only charge of the offspring, but have also to share, and that largely, in the husband's occupations, the brain capacity of the two sexes shows much less difference. The difference, according to Le Bon, between the average capacity of the skulls of male and female Parisians is almost double that found to obtain between the skulls of the male and female inhabitants of Ancient Egypt. Civilization, by giving increased exercise, especially to the male brain, has, there is good reason to believe, gradually produced that increase of brain capacity which now distinguishes the civilized from the savage races of mankind. Nowhere has this influence been more conspicuous than in China, whose culture, if not of the most advanced kind, has the advantage over all others in the great length of time it has endured. The Chinese are, as might have been expected, a big-brained people; indeed, the only statistics of Chinese brain-weights available show them to exceed all other nations in this respect. A few years ago the brain-weights of 11 adult male and of 5 female Chinese—the chance victims of a great typhoon at Hong-Kong—were obtained. These belong, with one exception, to the coolie or lowest grade of Chinese society, yet the average brain-weight of the males reached 50½ oz., and that of the females 45½ oz. This is an average not attained, so far as yet known, by any other nation, it being fully 6 oz. above that of the average negro, 1½ oz. above the European, and $\frac{1}{2}$ oz. above the average Scotsman. That civilisation has been the main cause of increase in the size of the brain there can be little doubt. To admit, therefore, that the heads of the British people are now growing smaller, would be to confess that the resources of civilisation were indeed exhausted, and that, as a people, we had begun a retrograde journey towards the barbarism from which we originally emerged.

THE SKIN, AND ITS MANAGEMENT IN HEALTH.

By Dr W. ALLAN JAMIESON.

In order to protect the delicate structures of which the body of man and the higher animals consist from rude contact with the external world, it has been sheathed in a tough yet sensitive and elastic covering, which is known as the skin, and I propose this evening to tell you something of its construction, as well as to point out what are the various functions or offices which are performed by it, as one and an important part of the living body, and also how to treat it so as to maintain it continuously in a condition of healthy activity, as well as to prevent its becoming as far as possible the prey of disease.

Simple though the skin appears to be, it is a complicated organ, but we may speak of it under three divisions. 1*st.* The skin proper; 2*d.* The glands contained within it which supply oil and perspiration; and 3*d.* The appendages which it bears—the hairs and nails.

The outer surface of the skin is comparatively dense and hard, so as to resist the more or less destructive influences of weather and occupation. It is known as the cuticle or scarf-skin, and is constructed of an infinite number of thin horny plates or scales, laid one on the top of another, and firmly attached except on the very surface, where they become gradually loosened and are constantly being cast off. This shedding of the outer layer of the skin is nearly imperceptible in health. It is this which makes up most of the cloud of dust, which flies off when a stocking is shaken, after having been worn a few days. This bran-like powder consists mainly of horny plates which have done their duty, have become dry, old and useless, thus loosen, and fall off. The thickness of the horny layer varies in different parts; it is thickest on the soles of the feet and palms of the hands, thinnest on the eyelids.

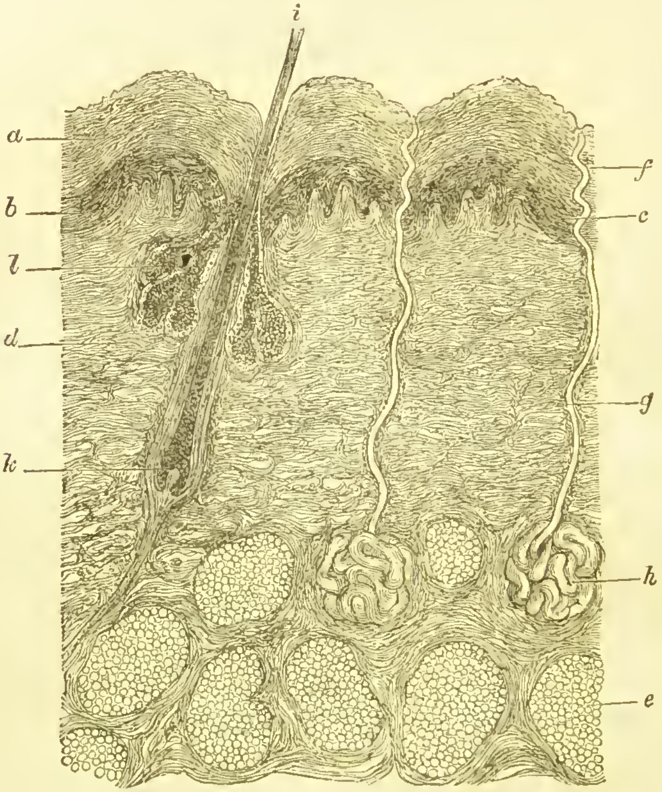


Fig. 1.

ection perpendicularly through the healthy skin. *a.* Epidermis or cuticle, *b.* mucous layer with pigment, *c.* finger-like projections of true skin, *d.* true skin. *e.* fatty masses, *f.g.h.* Sweet gland and tube or duct. *i.k* Hair, with its follicle and papilla. *l.* Sebaceous gland attached to hair follicle.

Underneath this layer the skin is more succulent and soft, and is made up of numbers of bodies called cells, each actively growing, united to one another by a transparent cement substance, and further joined in the deeper layers by fine spines or prickles, which project from their surface and interlace. This layer is called the mucous layer, and just as the mucous membranes of the inner surfaces of the body secrete or form a peculiar watery fluid called mucus, which keeps them moist and ready for the duties they have to carry out, so the mucous layer of the skin secretes the outer horny covering which lies above it and protects it. It used to be thought that these actively growing cells became themselves changed into the horny outer plates, by a gradual process of change. The most recent researches shew that such is not the case, but that the outer cells are distinct from those deeper, and secreted or produced by them, not merely themselves become thin, dry, and hard.

The colour of the skin, brown, black, olive, or white, is due to the shade of the deepest cells of the mucous layer. These, only slightly tinted in the white races, are much more intensely so in the dark. Both heat and light tend to increase the proportion of colouring matter in the skin, hence the bronzed face of the soldier who has been exposed to the Indian sun, and the brown patches on the front of the legs of furnacemen and others, who stand for hours before glowing fires, though protected from its light by their clothes.

Still passing deeper we come to the true skin, that part which in animals, when tanned, gives body to leather, which contains those fine tubes, whose office it is to convey to it its supply of nutritive fluid—the blood. Suited to its requirements, this part of the skin is made up of a mesh work of fine fibres, which interlace so as to compose a structure like felt, tough yet elastic. Within this the bloodvessels branch and divide with ease, and are sustained and separated. It is delicate and close on its external part where it underlies the mucous layer; looser and more open deeper down where the sweat glands and roots of the hairs are embedded in it. The openness of texture of the deep portion gives the secreting part of the glands room, permits the skin as a whole to move, and it is in this part that water accumulates in dropsy. The surface of this true skin is not smooth; it rises into points or prominences which, like so many fingers, push themselves into the mucous layer, and thus bring the ends of the nerves nearer the exterior of the skin, so that we can feel with greater exactness, and also a larger surface is obtained than if the top was flat. Still deeper, the mesh work is very open, and here contains fat, which in life is fluid, and fills minute bladders. The office of this fat is partly to give roundness and plumpness, partly to pad and protect, and partly from its great non-conducting power to keep in heat.

The skin is richly supplied with blood, and the vessels which contain this form three important net-works. One of these surrounds the glands of the skin, and ministers to their nutrition. Another runs somewhat horizontally at the deeper part of the true skin. A third, also horizontally, at the bases of the finger-like projections on its summit. Into these it sends loops. As in all other parts, the blood is conveyed to the skin by arteries, and from it by veins, which communicate by fine hair-like tubes. The mucous and horny layers contain no bloodvessels; but fine nerves terminate in and among the cells which compose the former. And when the horny covering is removed, as by scraping against a rough stone, the quick, namely, this tender mucous layer, is exposed and blood immediately oozes out. The delicate capillaries, as the hair-like terminations of the bloodvessels are called, give way under the pressure of the circulating blood within, having no longer the support of the cuticle, while the fine terminations of the nerves being laid bare, manifest their resentment by the sensation of pain.

There are, however, other structures in the skin proper. One of these is an elastic substance, which is distributed through the skin in fine curled threads. These, like a coil of watch spring, when straightened tend to recover their natural shape, and thus restore the skin when stretched as by the bending of a joint to its smooth condition. The elasticity of these fibres is greater in youth, and becomes lessened as age advances, hence the skin, often stretched in one particular direction, does not quite recover itself, and, as a result, wrinkles make their appearance. This is partly the cause of the furrows which care, anxiety, or ill-temper stamp on the face. Another factor of these is the muscular structure in the skin, an element which regulates its functions in a remarkable manner. There are two kinds of muscle distributed through the skin. One of these is scarcely found except in special regions, as the face, hand, &c., the other nearly everywhere. The first form is distinguished by being marked with fine cross bars or lines, and is under voluntary control. By the contraction of its fibres the skin is thrown into folds, and thus we are able to express the feelings and emotions, slight changes in certain muscles giving an entirely different cast to the features. But far more important as regards the well-being of the body are the non-striped or involuntary fibres of muscle. These are not directly under the influence of the will, but contract and relax in response to alterations of temperature, or to mental states, as fear, which causes their contraction and blanches the face, or shame leading to their relaxation, which permits an overfilling of the vessels of the skin, and the tell tale blush appears. These involuntary muscular fibres are arranged in various ways. Some obliquely, which, when they contract, compress the component parts of the skin together, and make it thinner. Some lengthwise at the base of the little prominences on the true skin; these check the outflow of perspiration. Some to the hair glands; these, when they shorten, make the hairs stand up, and squeeze out the oil from the oil glands, thus preventing it from drying up, and so choking the apertures. When the surface of the body is exposed to cold, these little muscles contract in all directions, force the blood from the surface, lessen the production of sweat, and thus maintain the natural heat of the body by diminishing evaporation from its surface. On the contrary, when we are exposed to heat, either from the sun's rays, or, what is practically the same thing, when we exert ourselves and thus become warm, these muscles relax, allow more blood to flow to the surface, the sweat glands act with more energy, the surface becomes moist, but with a salt fluid which evaporates slowly. And this in drying cools down the exterior, and maintains the uniform temperature of health. It is necessary here to tell you what that temperature is. Whenever the heat of the body rises above 98·5 degrees Fahrenheit, the condition is that of fever. The external temperature of the body, say in the armpit, may be a little below this without any departure from health. If it exceeds it at all, at least for any length of time, there is something wrong. By the action of these little muscles, then, the body is maintained at or below the temperature of 98·5°. In saying this, however, I do not mean to exclude the bloodvessels themselves from bearing their part. The tubes of which they consist are both elastic and contractile, and they, as well as the muscles of the skin, are under the control of the nerves, which, partly influenced by the will, but more particularly automatically, induce their dilatation and contraction as the necessities of the body require. They thus regulate exactly the amount and proportion of nutriment conveyed in the blood to each portion of the skin, and maintain it in vigour.

There are implanted in the skin at various depths three species of glands. One of these provides perspiration or sweat, another an oily material, and the third hair. This latter is also looked on as an appendage of the skin, but, as will be seen, it may be regarded as much a secretion as the sweat is.

The sweat glands consist partly of a coiled-up tube lined with secreting cells, and planted deep down among the fatty substratum; partly of a long duct, also lined with cells, leading upwards from the coil; partly of a tunnel without any proper walls, which runs spirally through the upper layers of the skin. The openings of the sweat glands, which are set with considerable regularity, can be seen with a strong magnifying glass as little pits or depressions on the points of the fingers, between the ridges which occur there. These are what are popularly known as the pores of the body. Their total number varies in different persons, but has been estimated at in round numbers 2,300,000. From this estimate some conception of their importance may be derived.

The sweat, which is a compound fluid made up largely of water containing common salt in solution, also some fatty material, is continually being poured out. Though the openings on the surface are free no sweat can, when the body is at rest or not too warm, be seen to ooze from them. This is in consequence of the spiral arrangement of the outer part of the duct, by means of which the perspiration soaks the outer horny layer and keeps it pliant and moist, being thus imperceptibly exhaled from the surface, constituting what is known as the "insensible perspiration." The total amount of watery fluid which thus escapes by the skin has been calculated at two pounds or pints daily. This is largely increased by exercise, warm weather or rooms, etc., and bears a direct relation to the quantity given off by the kidneys and lungs. How important, therefore, it is that the perspiration when being freely poured out should not be too suddenly checked. When this happens the lungs or kidneys are called on to do increased work without due warning, and they and other internal organs, as the liver, stomach, and bowels, are liable to become all at once too full of blood and inflamed. When one is tired after exertion, and thus in a depressed and weakened state, and freely perspiring, should this evaporation from the surface be rapidly checked and dried by sitting in a current of air—a draught as it is called—some internal organ becomes congested and we "catch a cold." Hence arise jaundice, acute indigestion, diarrhœa, as well as inflammation of the lungs or kidneys. This may sometimes be warded off by again quickly restoring the action of the skin by a hot bath, combined it may be with a tumbler of toddy. In most cases the mischief has been done ere this is resorted to.

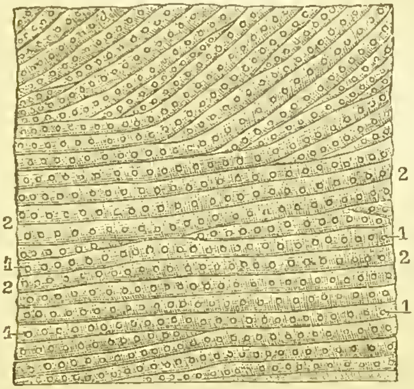


Fig 2.

Openings of the sweat glands on the palm of the hand. Magnified four times. 1. Openings of glands. 2. Furrows or ridges between the lines of openings.

It is thus seen how completely in harmony all the functions of the body work together in a condition of health. In cold weather the skin is least active, more water is given off by the lungs and kidneys, consequently there is more danger should inflammation then attack them. Again, in summer the skin pours forth its watery excretion more abundantly; this, in evaporating, cools down the surface and maintains the uniform temperature of health, while the kidneys often secrete more scantily. Every one must have remarked that when a sudden change of weather from hot to cold occurs the kidneys act at once very freely. This is simply due to a rapid diminution, in consequence of the lowered temperature, of the insensible perspiration. The sweat is usually acid. Sometimes it becomes intensely so, as in rheumatic fever; on the other hand, when profuse it may be alkaline or neutral, and then it putrifies readily, giving rise to odours which are extremely unpleasant, both to the person and to those around him.

The second variety of secreting glands found in the skin are the oil glands. A modification of these are the glands which form the wax found in the ear passage. These oil glands, or sebaceous glands as they are called, are commonly placed in close association with hairs. Most of them indeed open into the sac, or follicle which produces the hair, and the fatty material which they provide is conveyed gradually to the surface by the hair in its process of growth. It thus oils the hair as well as the skin. Each gland consists of a number of pouches containing cells, which elaborate the oily material, and finally burst and set it free. Sometimes this oily matter is produced in too fluid a state, and when so, can be seen to ooze in minute drops from the oil glands of the nose and cheeks. Dust and smoke adhere easily to this, and the face constantly looks grimy and unwashed. There are no oil glands on the palms or fingers, but the sweat secreted there is greasy; and this explains why, when a hand moist with perspiration is placed on paper it leaves a stain. In some of the lower animals, the aquatic birds in particular, these oil glands are much more highly developed. In them they oil the feathers which otherwise would become wet and heavy; and hence the saying that "our words made no more impression than water on a duck's back." Sebum, as this oily matter is termed, tends when allowed to accumulate, and in consequence of the heat of the body, to become rancid, and smell strongly. This is more apt to occur in the dark than the white races of mankind. It would appear that every one has an odour peculiar to himself, and it is this which enables the dog to recognise his master, the bloodhound to track the outlaw. When the hands are brought in contact with animal or vegetable matter in a state of decomposition, the smell of the substance touched attaches itself to them, and in all likelihood especially to the fatty secretion. Soap does not remove the odour. Carbolic acid or Condy's fluid disguises it for a time, to reappear nearly as pungently as ever. If, however, as Dr Foulis has suggested, we smear the hands well with turpentine which dissolves the oily secretion, and then wash them with soap, the unpleasant smell will be found to be permanently and harmlessly removed. This is not a mere matter of sentiment. Some poisonous materials can thus be conveyed from one person to another. By employing turpentine these are rendered innocent, and the danger of contagion lessened materially if not altogether abolished.

The third series of skin glands are those which produce the hair, and these exist nearly universally. On the palms and soles and one or two other situations they are absent. These glands are seated at various depths; those which form the fine down which covers the arms, back, &c., are near the surface, those whence the hair of the head and beard grow are planted deep among the fat cells under the skin. The hair glands are only foldings in or pouches of the skin; and the hair is nothing more than the horny covering of the skin, which has grown into a thread-like form. The pouch which produces the hair is wider below than above, and has a nipple-like projection at its deepest part, into which bloodvessels and nerves run. This is the active agent in forming the hair. The root of the hair has a dimple, much like the hollow in a champagne bottle, corresponding to the hair papilla, and is soft. As it grows upwards it becomes firmer, and when it emerges from the skin the hair consists of a bundle of fibres, variously coloured in different individuals, bound together by flat plates, the lower of which always slightly overlaps the next above. This overlapping serves several purposes. One of these is that, as the hair grows, the projecting edges of these plates, scraping the sides of the tube surrounding the hair, carry before them any particles which have become detached from the inside of the pouch, and also the oil secreted by the oil gland which opens into it. Thus the hair literally sweeps out its own follicle. When the hair has become free on the surface, this arrangement permits us to brush dust, &c., from its root to its point, and also favours the conveyance of perspiration or water from the body. Hairs are set at an angle to the surface, not perpendicular, and in what are called whorls or spirals. This spiral arrangement of the hair is well seen on the crown of most boys' heads. Hairs are not in general quite round, but somewhat oval, and the greater the oval the more the hair tends to curl. Hair, too, is nearly indestructible by time alone. A coil of hair, with the pins of jet still sticking in it, once the ornament of a young Roman lady, was found the other day quite fresh in a stone coffin near York, carrying us back to the dawn of the Christian era.

During life, however, each hair has a definite period of life. This is much longer in some persons than in others, and bears some relation to the state of health. A calm, easy life, a placid disposition, and a well-nourished body, offer a combination of circumstances most favourable to the production of long hair. Such was in all likelihood the condition of that worthy burgomaster of Brock, a sleepy town in Holland, of whom it is recorded that he had so voluminous a beard that he kept it tied up in a bag. One day having permitted it to hang down unrestrained, he tripped over it on the stair of the Court-house, fell and broke his neck. The nutrition of the hair is often a good index of the state of health. Thus when it is glossy and pliant, does not fall off much, is weak or split easily, the possessor may, as a rule, be considered as in good health. In most persons, as age advances, it becomes white. This is rarely if ever unbecoming. It is said that a lady once remarked to Douglas Jerrold that she could not understand why her hair was turning grey, unless it was occasioned by the essence of rosemary which her maid was in the habit of using to wash her head with. "I fear," said the witty dramatist, "it is much more likely to be due to the essence of time." Some, however, apparently forgetful that there is something incongruous between a wrinkled cheek and dark hair, try to improve on nature by using artificial dyes. Though most of these contain lead, probably any harm they can do is exaggerated, yet they are rarely successful because too much is attempted, and the fraud becomes patent to all. Each season in the year of life has its peculiar and suitable tints, which blend to form a consistent and beautiful whole.

The nails are plates of horny material which correspond to the outer layer of the cuticle. They, like the hairs, grow from a root, the imbedded part of the nail farthest from the point of the finger. They are, however, firmly attached to the bed or quick, over which in growing they slide, receiving little, if any, increase of thickness from it. The object of the nails seems to be to make the point of the finger firmer than it would be did it end round and pulpy. Nails grow more quickly in the young than the old, in summer than in winter; and the rate of growth of the nails on corresponding fingers of each hand is not quite uniform. It averages $\frac{1}{30}$ of an inch a week on the hand, less on the feet. During severe illness, such as rheumatic fever, the growth of the nail at its root is arrested, and when recovery has taken place and the nail increases again, a groove appears by-and-bye on its surface, which in depth and breadth bears relation to the length of time the illness has lasted. This may serve to show what a shock such illnesses give to the system generally.

Dried up and decayed cuticle often accumulates by the side of the great toe nail, more particularly on the side next the other toes. This being picked out with the scissors, when the nails are cut, the pressure of the boot, too frequently made very narrow at the toe, forces the edge of the nail against the tender part from which the accumulation has been removed. The pressure leads to the formation of a sore; proud flesh sprouts out, and the nail is said to have "grown in," necessitating sometimes a painful operation for its cure. All this might be avoided were boots or shoes with broad square toes worn, the toe nails simply cut straight across, and the sides cleaned by means of a nail brush, soap, and warm water, and never picked. When dirt gathers under the free edge of the finger nails it should not be scooped out with a pen-knife, but washed away with soap and water and a brush. Picking the nail raises it unnaturally from its bed, and more dirt collects. It should be remembered, too, that children's feet grow fast, at an early age especially, and shoes soon become too short—the great toe, prevented from becoming longer, bends towards the second toe, the foot is weakened, and in time bunions form on the ball of the great toe. It is rare to find an absolutely natural great toe, just because at some time too short shoes have been worn when the foot was growing.

Having placed before you this sketch of the structures which compose the skin and its appendages, its management in health must now engage our attention. Cleanliness is in great measure the outcome of a state of civilization. Among savages when in their wild condition washing is almost unknown. The human being in a state of nature uses water simply to cool his body in summer, never to cleanse it. In winter he wears unchanged the skins or mats which form his defence from the cold. The higher the state of civilization the more the luxury of bathing is indulged in. Yet there are many thousands in this country who never wash from year's end to year's end. Two Glasgow lads were disporting themselves in the Gareloch one warm day during the fair holidays. One remarked to the other how black his skin was. "And so would yours be," was the reply, "if you had not touched water since this time last year." History repeats itself, and just as bathing was an art among the ancient Greeks and Romans, so the multiplication of water cure or hydropathic establishments among ourselves must be looked on as an evidence of the estimation in which baths are held by the middle classes now.

No sooner have we opened our eyes and uttered our first shrill cry as helpless infants, than our nurse sets to with a will and soaps and scrubs us till our skin glows rosy pink. For six months, perhaps longer, be our home the poorest, we have a daily bath at least. As we begin to move about, and come more directly in contact with dirt, by a strange inconsistency we are less often washed; and by the end of our second year we may, if mother is also nurse, and a successor to the honours of the bath has appeared, be put off with a weekly Saturday night's tubbing. When a little older the boy or girl in many a poor home is well off if he even gets that. I know there are many difficulties in the way, when rooms are small and furniture scanty. But a great deal might be done by hanging a sheet across a corner of the room, behind which a thorough wash might with due regard to propriety be obtained.

What happens when the skin is not regularly washed and kept clean? The dust which is always around us, the particles thrown off by our clothes in course of wear, and the secretions which are perpetually being poured out by the glands of the skin themselves, all accumulating, plug up the innumerable openings, and prevent their working. Hence an indispensable agent in getting rid of much worn out material from the system acts but very imperfectly, and more work is thrown on internal organs to take its place. Health suffers, and though the body with wonderful adaptability to circumstances submits to much, still discomfort, to say the least, to the individual arises, and annoyance to the more cleanly members of society. Singular to say, our paupers dislike extremely the bath which is the necessary introduction to the workhouse, and many members of the lawless classes detest the prison regulations as to washing. Hence that cleanliness so scrupulously observed by many of the lower animals seems to be an acquired habit in man.

The skin from being oily cannot be cleaned by water alone. And though the morning cold bath is bracing and invigorating, and aided and supplemented by friction with a rough towel, removes much of this secretion, some substance which will so alter the greasy coating as to render it capable of being washed off must be employed in addition. This is found in soap. Now soap consists of a combination of an alkali, such as soda or potash, and oil or fat. These when mixed and boiled in certain proportions form a definite compound, either hard when soda, or soft when potash is the alkali. There is always in soap some free or uncombined alkali, and this, when the soap is rubbed with water on the body, unites with and renders soluble the oily material of the skin. Potash soaps contain too much and too strong an alkali, hence when the skin is washed with soft or black soap, the natural oil is so thoroughly removed, that the skin is left dry and harsh, and feels to its owner as if too tight for him. The injurious effects of the constant use of these strong soaps are seen on the hands of washer-women, in whom they produce a disease which cannot be cured unless the employment is abandoned. In a well-made soap, however, a soda or hard soap, compounded from pure fat, thoroughly boiled, and then matured by keeping—all good housekeepers know the economy there is in having soap for some time in the house before it is used—the amount of free alkali is small. This cleanses the skin, but not entirely removing the oil, leaves it soft and pliant. All soap should be entirely washed off with water before the skin is dried. Unless this is done the face looks shiny and smooth, more suggestive of an attempted than a completed washing. "Use doth beget a habit in a man," thus the more regularly and constantly soap is employed the more it becomes a necessity of life. Those who wash daily with soap miss it more when from illness or any other cause they are deprived of it, than those to whom its use is merely occasional.

A word must be said about various kinds of soaps. Old Castile soap or Pears' soap are excellent, but expensive. Very pure soap can scarcely be cheap. The fatty ingredients must be selected and pure; and the soap like good wine should not be too new before it is sold. All this costs money, and must be paid for. Pears' soap and transparent soap generally is further purified by being dissolved in spirit, which removes any accidental impurities. White soap made by respectable firms is usually pure enough for all ordinary purposes. Highly coloured and scented soaps, too often reserved specially for baby's use, are in general to be avoided, and so are medicated soaps. Sulphur soaps, for instance, are irritating, and so are carbolic acid soaps. The latter is sometimes useful as a disinfectant, but when kept, the carbolic acid evaporates, and with it any particular virtue. Coal tar soap is of a little value in some diseases of the skin, in most it does harm. One soap I can recommend, as it is made at present—Sanitas toilet soap. Sanitas is turpentine, through which a stream of hot air has been passed for a long time. The turpentine becomes chemically altered in the process, and this, when combined with a well-made soap, imparts to it an agreeable odour, and makes it more cleansing, though not too drying for the skin. A little of this soap goes a long way. The hair when washed with it feels free and clean on being combed. Sanitas fluid itself, diluted with four times as much water, makes a good wash for the hair. Honey soap is said to be a good soap. Glycerine soap is not, for the glycerine does not unite with the soap, and exudes as drops on its surface.

There are popular prejudices against washing certain parts of the body. One of these is that the face should not be washed with soap, as thereby the complexion would be injured. Now the reverse is really the fact. Dust and soot adhere to the oily material poured out by the glands of the face, and stop up their openings. Unless soap is used to keep them free and active, these glands become sluggish, and thus give rise to a "bad complexion." No doubt in many cases there are other causes at work, as indigestion, tight-lacing, living in close ill-lighted rooms—sunlight being as necessary to produce bright and fresh colour in human beings as it is in plants. Unhealthy occupations are also causes, and occupations which not in themselves unhealthy are made so unnecessarily. Thus many shop-girls are seriously injured, because their employers insist on their standing behind a counter for many hours without sitting down, even when not employed in attending on customers. I mention this particularly since attention has lately been drawn to this species of cruelty by the medical papers. The plan is a short-sighted one, for tired girls cannot so well or so cheerfully work as those refreshed by resting from time to time, when not actively engaged in selling. This is a real cause of not a few of the pale and spotted faces we see among shop-girls.

Again, colliers, perhaps other operatives, believe that washing the back weakens it, and thus leave it untouched. There is a trace of human inconsistency here, since their wives bathe their children's weak legs to strengthen them.

The feet though in constant use do not receive their due share of washing, though they need it as much or more than other parts which always in view are necessarily cleansed frequently.

Mothers and nurses refrain, possibly through a mistaken fear of giving cold, from washing that part of infants' heads on the top in front where the bone is defective at birth, popularly known as the "open of the head." Hence a greasy substance gathers, forms a thin crust, this turns rancid, and becomes often a starting point of those outstrikings on the face and head of infants which are ascribed to teething. This part of the child should be washed as often and as carefully as any other, dried scrupulously, and, if necessary, anointed with a little vaseline or cold cream to prevent scurf from collecting.

If at all possible, the whole body should be washed once a day. The best time is on rising in the morning, as then the plunge into water, which should be, at all seasons, about the temperature of 60°, is invigorating and refreshing after awakening from sleep. A very few minutes suffices, and the hardening effect on the body, rendering it less liable to be afterwards chilled during exposure to this variable climate of ours, is worth all the time snatched from sleep. A substitute for the plunge into water may be extemporized by dipping a towel in cold water, and thoroughly scrubbing the body with it. Such a bath causes the muscles of the skin to contract, lessens the amount of perspiration for a time, and acts as a tonic.

A bath should not be taken immediately or even soon after a meal. An hour and a-half at least should be allowed to elapse. This applies to all forms of baths. A cold one first drives the blood from the surface and blanches the skin, followed, if the exposure be not too prolonged, by an agreeable sensation of warmth, and a feeling of lightness and increased vigour. This is due to the bloodvessels again dilating and the warm current flowing through them with augmented activity. It is this pleasant afterglow which is the test of the beneficial effect of a bath or otherwise.

Unless it is experienced in some degree a cold bath should not be indulged in.

When the blanching of the skin, due to the sudden contact of cold water with its surface, takes place, the blood displaced from the skin congests internal organs, and this occurring when digestion is actively going on interferes with its progress, and disturbs its regular course. This also explains why persons sometimes feel sick after a bath, and why we pant when we step first into the sea, at least when the water reaches the level of the chest, the lungs being for a time overfilled with blood. A warm bath on the contrary raises the temperature of the skin above its natural standard, and withdraws blood rapidly from internal organs, as the stomach or brain. Faintness may thus be induced in those who have naturally little blood, or are otherwise not very strong. The brain in them, not at any time over well supplied with blood, becomes still less so, and faintness or actual fainting occurs. When we come out of the warm water and the skin is dried, the cooler air around us increases evaporation from the skin, and also drives the artificial excess of blood away from it, and we feel cold. Thus the warm bath has its uses, and there are times also when it cannot be employed without harm. It may be used beneficially to cool a fevered skin, and so it is constantly made use of in many children's diseases. Or, again, to restore the proper action of the skin, when this has been checked by exposure to cold or damp. When this has been done, however, the artificially induced warmth must be maintained by going to bed. Thus a warm bath pure and simple, and by this I mean one whose temperature is above 95°, should only be taken when this is possible immediately after. As thermometers are not always at hand, a ready way of estimating the heat of the bath is to plunge the naked elbow into the water, and thus we can very accurately determine it. There will thus be no risk of scalding children, as has been done, when the hand which often stands a high temperature is used as the test. A warm bath interferes with digestion by withdrawing blood from the stomach, and thus checking the process.

We can by certain medicines stimulate the sweat glands to increased activity, but as a means of perfectly and thoroughly cleansing the skin the Turkish bath stands unequalled. In it we have, first, profuse perspiration, due to continued exposure to a high temperature, then thorough cleansing by means of soap, and, finally, a gradual cooling down by a spray bath, whose heat is constantly diminished to nearly icy coldness. It must be borne in mind, however, that the Turkish bath does not agree with every one, nor is it to be employed except occasionally, for though producing at the time a sense of increased strength and buoyancy, its too frequent repetition is not without risk, and to it has been ascribed with some reason the origin of one form at least of skin disease. A remarkable instance of the effect of the Turkish bath on the skin was given by an Irishman, who, writing home to his friends, after describing how the bathman, during the shampooing process, scraped off layer after layer of accumulated dirt, declared that he finally triumphantly unearthed an old flannel under vest, of whose existence the said Irishman had had no recollection.

It may be well to say a word here as to bathing in fresh and salt water, and their influence on the skin. Sea bathing is admitted by all to be much more invigorating than fresh water. Much of this is due to the pure sea air, and to the rest from care and business which accompanies a residence at the seaside. But there must be a something in the water itself, and this has usually been explained as dependant on its higher specific gravity. Further than this we cannot at present safely go ; certain it is that a sea bath is more strengthening, and if from the presence of salt less cleansing, can be indulged in by those who would derive little advantage from a river or lake bath, though in the absence of sea water these are not to be despised.

Is it safe to bathe when warm and freely perspiring ? Yes, if from previous experience we are conscious of that pleasant glow on emerging from the water of which I have already spoken, and provided we are still vigorous and healthy. While the blood flows rapidly through the vessels, and the skin is turgid, a plunge into moderately cold water taken at once, and followed by friction in drying and then hasty dressing, is safe and advantageous. Should, however, the perspiration have ceased and dried, and the skin again become relaxed, a cold bath cannot be indulged in without risk. There is no subsequent glow and reaction, nausea is apt to supervene, and ill effects to the system generally to follow. Even a tepid or warm bath should then be taken with care.

Hard water is injurious to the skin. It makes it rough, and tend to chap, all the more if easterly winds are prevalent. Hardness in water chiefly depends on the presence of a compound of lime, commonly the carbonate. This, when brought in contact with soap, decomposes it. The lime unites with the oily acid, and forms with it a soap of lime, which is insoluble. The potash or soda thus set free unites too perfectly with the natural oil of the skin, and thus dries it. Boiling renders hard water somewhat less so. The carbonate of lime is held in solution in the water by free or uncombined carbonic acid. Boiling drives this off, and so much of the lime is deposited. This composes most of the crust which forms in our kettles and boilers. When only hard water is available, we can thus make it softer and less injurious to the skin. Rain or river water is preferable, if these can be had.

When persons grow old they not unfrequently become less careful about washing themselves. No doubt with failing health less regard for personal appearance, and possibly a degree of laziness, there is an explanation, but not always an excuse for this. But as the skin becomes more shrunken its glands are less active, and dirt and its own excretions accumulate in the wrinkles and furrows, consequently washing should be more carefully done, but with warm water.

The care of the skin, however, does not merely consist in washing it. Its due covering and protection are as necessary, perhaps even more so. There is quite an agreement among medical men that in our cold, damp, and too often sunless climate, nothing surpasses flannel or some woollen material as the article of clothing to be worn next the skin. Wool is a bad conductor of heat, and thus keeps in and maintains the warmth of the body. It absorbs the perspiration and oil, and takes up the dry scales which are being constantly thrown off. Thus it should be changed pretty often. Just about a hundred years ago Hugo Arnot gave as an instance of remarkable personal cleanliness, that the late Archbishop of Glasgow put on a clean shirt once a week! Though this would not excite wonder at the present day, the fear of changing body linen still lingers in the case of sick persons and children, whose comfort is interfered with and whose illnesses are sometimes prolonged through a false dread of their catching cold were this done. Provided that those to be put on are warm and dry, there are few instances indeed where a frequent change is not in every respect beneficial, care being taken that in the process the sick person is not unduly fatigued. In the case of children warm under flannels are very necessary, as they bear cold badly, and the younger the child the less resistant it is to it. Fashion still rules the day as regards the outer garments, but those next the skin should be warm and close-fitting. The same underclothes should never be worn at night as well as in the day; and, except in children, where flannel suits best, cotton or linen should be the material of the night-dress.

A whole lecture might be devoted to the hair, and yet its management in health need not detain us long. When short the hair may be washed, if desired, every day, and this practice, if commenced in early life, and continued, is said to postpone at least its becoming grey. It should be washed as often as necessary to keep it clean and its roots healthy. Any good soap may be used to wash it with, or the white of an egg well whipped up, which cleanses it without drying it so much as soap does. It is often recommended to wash the hair with borax. This cleans it, but leaves it dry, therefore very little should be used; and after the hair has dried some simple oil or pomade ought to be applied, to take the place of the natural oil which has been dissolved away. An oft quoted dictum of some one notwithstanding that "one cannot brush the head too much or the hair too little," brushing should be gentle, and a brush with bristles which are neither too stiff nor too closely set should be chosen. A hard brush breaks and bruises the hair, although it seems to be doing good by scraping off a cloud of scurf. One is apt to forget that the scurf re-forms faster than ever when thus roughly scratched away. Use, then, a soft brush, and use it gently. And wash the head once a week or fortnight, if not habitually daily. The teeth of the comb should not have sharp points, as these tear the skin of the head. *A small tooth comb should never be used.* It does more harm than a hard brush when employed to get rid of dandriff or scurf, and for any other purpose there are better and more certain methods. A little pomade does no harm, provided it is simple. Perhaps the best is made of equal parts of pure cold cream and vaseline, or cocoa-not oil and vaseline.

At present the natural style of dressing the hair of females may be said to be in vogue. Long may it continue so. And may we never see the return of pads or chignons or other artificial appendages or supports. No part of the body, ladies' waists and perhaps feet excepted, has been so much tortured by fashion, and baldness becomes every day more frequent in both sexes. In women dragging the hair over huge chignons, which themselves over-heated the head, caused it to fall off; and in men the style of head-covering usually worn is blameable for much. Blue coat boys, and the waifs and strays of our lanes, who mostly go bare-headed, have thick heads of hair and retain it long. The same may be said of peasants abroad, who work all day with heads uncovered, or with merely a handkerchief rolled round the head to protect it from the sun. The heads of hair of savage races are quite marvellous for their thickness. Those, on the contrary, who wear hats, especially hard or close-fitting felt or silk hats, lose it soon. No doubt there are other causes—hereditary predisposition, want or thinness of blood, anxiety and worry, still these are secondary. The hat confines the perspiration which rots the hair, and makes it scurfy and dry, while the hard rim of the leather lining band presses the bloodvessels of the temple against the skull, and thus starves the hair by diminishing its supply of nutriment. Hats, then, should first be soft and easy; and second, should be so ventilated that a current of air passes freely over the head. For this purpose it is not enough to have a few holes punched in the crown. The lining band should be made of soft material, widely separated from the hat by a space, and holes made in the sides and front of the hat itself. This allows free ingress and agress of air, and were this plan adopted and made use of in all head coverings, we would have fewer colds in the head and fewer bald men. The tall or chimney-pot hat worn as dress in this country is too heavy as a rule. In fact it is not a suitable covering for the head in a climate like ours, where rain and particularly high winds prevail. In France and Italy the hats made and worn are much lighter than ours, which are necessarily stronger and heavier to resist the wind. Hence a more rational hat would be a lower and softer one. And when we become wise enough to dress according to the dictates of reason and not fashion, such a hat will be universal; as it is, some clergymen alone adopt it in town.

One reason why women are less often bald than men is undoubtedly because their heads are less closely covered.

Cutting the hair frequently causes it to grow thicker, at least if the hair be moderately short. When the ends of long hair tend to split, the hair should be trimmed at its points, each hair being cut a short way above where it has split, and a little oil applied to the ends. There is no virtue whatever in singeing the hair.

In conclusion, it will be evident that scrupulous cleanliness and suitable protection from cold and variations of temperature are the means requisite to maintain the skin (and with it the body generally, so far as the influence of the skin is concerned) in activity and health.

HOW WE DIGEST OUR FOOD.

By JAMES FOULIS, M.D., F.R.C.P.

MAN stands at the head of the animal world and has all things in subjection under him, yet he comes from an extremely minute germ or egg, not more than the $\frac{1}{200}$th part of an inch in diameter, and weighing scarcely the $\frac{1}{1000}$th of a grain. An adult man weighs about 130 pounds, so that he weighs a thousand million times more than the germ from which he started.

This little egg or germ, if placed in suitable conditions, has within it the power of absorbing or imbibing nourishment. It has no lungs, no stomach, no heart or any trace of an organ of digestion; and yet it will grow and develope into a perfect human being, if the conditions favourable to such development are present. The first trace of the development consists in the division of the little egg into two halves. It actually divides itself into two halves—then each half divides itself, and then each quarter divides itself, and this division goes on until the whole egg is reduced to an immense number of little bodies called *cells*. Each of these little cells, though much smaller than the original egg, is very like it in structure. The mass of cells thus produced continue to absorb nourishment from the mother's blood, just as the egg did in the first instance. Presently the cells arrange themselves in a peculiar manner, some of them develope into the brain and spinal marrow, others develope into heart and lungs, others into bone, and so on until the perfect little human being is formed. Now, what I have told you of the first steps in the development of man, is exactly the same as takes place in the first steps of the development of every vertebrate animal. In the cat, the dog, the monkey, the elephant, and all the other animals of this class, a minute egg is the first trace of the animal. Division and subdivision of the egg takes place, and then the minute bodies or cells formed by this process of division gradually give rise to the different organs and the distinguishing characteristics of each animal.

I mention these few facts about the first steps in the development of man, because I wish to direct your attention to the wonderful power possessed by the small bodies which we term "*cells.*" I shall have to show you that in the human body there are millions upon millions of minute cells, all undoubtedly derived from the original germ or egg, and that these cells are really the means by which we digest our food. I shall have to show you that although we eat food, we, as individuals, do not digest it. We cannot digest our food, let us try ever so hard. We do not digest our food by any effort of our wills. We cannot convert our food into flesh and blood any more than we can control the beating of our hearts. The digestion of food, or the process of converting it into soluble material so that it may pass into the blood, is entirely carried out by the agency of countless millions of cells lining the alimentary canal, over which we have no direct control whatever. I hope to make this clear to you by-and-by.

Before the child is born, although it possesses a stomach and intestines, a mouth, and other organs of digestion, it does not *eat* food. Such nourishment as it requires is absorbed from the mother's blood. The mother eats the food and digests it, while the child absorbs such nourishment as is necessary for its development. This absorption of nourishment by the child takes place without either the mother or child knowing anything about it!

When the time has arrived for the young child to lead a separate existence, it comes into the world the most helpless of all animals. Before its birth no air entered its lungs; but now on coming into the world it opens its mouth and begins to cry lustily. By this means it breathes the breath of life; but with this breath of life it also breathes in a tendency to death, for if it breathes the oxygen of the air it begins to waste or burn away, and if not fed with milk or other appropriate food it will surely die. Let it have food, and the minute cells which constitute the essential parts of the organs of digestion will convert this food into flesh and blood, and the young creature will grow faster than it can waste away; and thus it will pass from childhood to boyhood, and from boyhood to manhood.

When fully grown a man has more than 200 bones in his skeleton. In the skull we see the cavity which contains the brain —the organ of mind. The eyes, the ears, the nose, the mouth, are situated in close relation to the brain. In the vertebral column is a tube which contains the spinal marrow, and attached to the spinal column are the ribs, which enclose the chest cavity, in which are placed the heart and lungs. Then we see the different bones which form the arms and legs and hands. All these parts are clothed with muscles.

There are more than 400 muscles in the human body. The muscles, by contracting, move the limbs. It is by means of the muscles that we can walk about and move our bodies from one place to another. There is a very remarkable muscle called the *diaphragm* or *midriff*, which runs across from the bottom of the ribs to the spine, shutting off the cavity of the chest from the abdominal cavity. In the cavity of the abdomen are placed the organs of digestion, the *stomach*, *liver*, *intestines*, and *pancreas*. In the chest the heart and lungs rest on the upper surface of the muscle called the diaphragm.

The whole body is clothed with the skin or integument. This skin can be easily removed from all parts, but at the margins of the various apertures of the body it seems to stop, and becomes continuous with the mucous membrane which lines all those internal cavities, such as the alimentary canal, into which the apertures open. Every well nourished body has a considerable quantity of fat between the skin and the muscles, and it is this fat which gives such beauty and roundness of form to the human body. Sometimes the fat is of enormous thickness. In very stout people fat under the skin is sometimes several inches in thickness. It is often deposited in a very thick layer under the skin over the abdomen. In this situation I have seen it seven inches thick. In the skin over the surface of the body there are numerous sweat glands. These glands are minute tubes, and are about two and a half millions in number, and to show you how important they are as organs of perspiration, I may tell you that if these little tubes were placed end to end, they would form one tube 28 miles in length. While you judge of the beauty of the human body when properly nourished, as depicted in the statue of the Three Graces, as a contrast you may look on the horrible effects of starvation. In the famine at Orissa, in India, several years ago, many thousands of our fellow-creatures were starved to death.

What I now show you is a photograph, from life, of some of the poor starved creatures. Only those who have witnessed death from starvation know of its horrors. Let us who have a good supply of food, although from other nations, think twice before we venture to tax the food supply of this country.

Now the body of a living man is always in a state of activity. Even when he is asleep, although the head and limbs are quiet, the heaving chest shows that some parts are active. At all times, day and night, the heart is beating, driving the hot blood to all parts of the body to nourish the various tissues, and to take up the effete and used up material which are conveyed to the lungs, skin, and kidneys, to be thrown off from the body as excretions.

All work means waste. No fire can burn without the coal being consumed, and ashes remain.

Suppose we have a room with walls of ice. As long as the air in the room is *ice* cold, the walls of the chamber will not melt. Let us carefully weigh a healthy living man, and then make him walk up and down in the room for an hour. In doing this he will clearly exert a good deal of mechanical force. At the end of an hour we shall observe that a certain amount of ice has been melted, showing that the man has given off heat in abundance. And if we now examine the air of the room, we shall find that it contains moisture which has been breathed out by the man, and has been given off from his skin by perspiration. If at the end of an hour we again carefully weigh the man we shall find that he has lost weight. Now, from all this, we learn that a living active man constantly exerts mechanical force, gives off heat, evolves carbonic acid and water from his lungs and skin, and undergoes loss of weight.

Now it is quite clear that this sort of thing could not go on for long without the man wasting away to nothing.

Long before this takes place, however, the man feels hunger and thirst, a craving for food and drink and fresh air with which to build up and to restore the body to its former weight.

For this purpose man takes into his mouth, and then passes into his alimentary canal, every day a certain quantity of food in the form of meat, bread, butter, water, and the like. It is important that you should ever bear in mind that the substances used as food come under four heads:

1st. The nitrogenous food, such as the gluten of wheat, the albumen of white of egg, the fibrine of blood, the syntonin of muscle, the casein of cheese.

2d, Fatty Foods, such as all vegetable and animal oils,—as, butter, bacon, and oils, &c.

3d, Starchy Foods, such as starch and sugar, and nearly all the farinaceous foods, such as arrowroot, corn-flour, potatoes, come under this head.

4th, Mineral matters,—under which head are water and the salts of various metals.

Food, then, in the form of nitrogenous, fatty, starchy, and mineral material, separately or altogether, are introduced into the alimentary canal. *The whole purpose of digestion is to reduce these foods into a condition either of solution or extremely fine division, in order that they may readily pass into the blood through the thin membranes which form the walls of the capillary blood-vessels in the mucous membrane of the alimentary canal.*

THE TEETH.

In the mouth the food is subjected to two different operations, viz., Mastication and Insalivation. By mastication, or chewing, the food is cut up and ground down by the teeth to a state of minute division. This is entirely a mechanical process. It is necessary, in order that the food may be properly acted on by the different digestive fluids. The teeth are very important organs of digestion. There are marked differences in the teeth, both as to structure and action, corresponding to the habits of the animal and the food it eats.

In fishes and serpents the teeth are generally in the form of spines curved backwards; they serve to catch and hold their prey, and to prevent its escape. In such animals the food is swallowed whole or in large masses, and the digestion is very slow.

In animals which eat flesh, such as the lion, tiger, cat, and dog, there are three different kinds of teeth. The cutting teeth, or incisors, are six in each jaw; these cut the food like a pair of scissors. Next to these are long teeth, in the form of tusks; they are pointed and conical. They enable the animal to get a good hold of its prey, and they pierce the flesh through and through. Then come the molars, or grinders, eight or more in number on each side; they are large and broad teeth, with sharp edges, which have several points or curps, like the teeth of a saw. In flesh-eating animals the chewing process is very imperfect. The flesh is not ground down, but is only pierced through and through, and mangled before it passes into the stomach.

In animals which live on vegetable food, such as grass, the cutting teeth, or incisors, are only in the lower jaw in those animals which "chew the cud;" but in the horse they are found in both upper and lower jaws. In these animals the incisors simply nip off the blades of grass. The chewing is performed by the grinders. The grinders are large and flat, and their surfaces have projecting ridges of hard material, called *enamel*. By the lateral rubbing motion of these rough surfaces together the food is reduced to a soft pulpy mass.

In the human being the teeth present the characters of the teeth of the flesh-eating and of the vegetable-eating animal.

The incisors are four in number in each jaw. The canines are much less prominent and pointed than in flesh-eating animals. The molars, or grinders, are thick and strong, and have on their surfaces little points or curps, like we see in the teeth of flesh-eating animals. There can be little doubt, from the structure of the teeth alone, that man is both a flesh and a vegetable eating animal. Man chews his vegetable food just as perfectly as do the grass-eating animals, and he chews his meat much more perfectly than do the flesh-eating animals.

The teeth perform a most important part of the digestive process. If the food is not properly chewed or masticated, and is swallowed in masses or undivided lumps, it will remain in the stomach a long time undissolved and prove to be a source of irritation to the delicate mucous membrane of the stomach, but if it is properly chewed, and reduced to a state of pulp before it is swallowed, it is then readily attacked by the gastric juice and other fluids, and is rapidly dissolved; hence the great importance of thoroughly chewing food before it is swallowed.

In the human being, each little tooth consists of a crown, a neck, and fangs. The crown is that part which projects above the gums, and is covered with a layer of enamel—the hardest substance in the body. Beneath the enamel is the dentine, a substance like ivory. In the centre of the dentine is a cavity termed the *pulp cavity*, which contains the tooth pulp, a very sensitive body, consisting of bloodvessels and nerves which enter the tooth through a small opening at the end of the fang. Where the teeth rub against each other the enamel and the dentine wear away; but the dentine being much softer than the enamel, wears away more quickly. In the front teeth of animals such as the beaver, the rat, the hare, and the rabbit, the edges are very sharp. The sharp edge consists of enamel, which has not worn away so quickly as the dentine.

In the human being teeth are objects of great beauty when free from decay and properly arranged. Decayed teeth injuriously affect the health in two ways. When broken down they do not grind the food properly, and when decayed they make the breath offensive, because there is always an offensive odour around a decayed tooth. If the teeth are not cleaned day and night, little particles of food get in between the teeth, near the gums, and irritate the latter, which become inflamed, and a white cheesey looking material is apt to accumulate on the edge of the gums. If a very small speck of this white cheesey material is mixed up with some spittle and examined under high powers of the microscope, it is found to consist chiefly of a sort of fungus, and in among the branches of the fungus are myriads of minute, rapidly moving animalcules called *vibrios* and *bacteria.* It is an extraordinary sight, and once a person has seen it I think he will not neglect to clean his teeth day and night. The teeth may be well cleaned by brushing them with soap and water morning and night. After cleaning the teeth in this way, the mouth may be made sweet by washing it out with a teaspoonful of Condy's fluid, dissolved in a tumbler of warm water.

THE SALIVA.

As the food is being chewed, it is at the same time mixed with the *saliva* or spittle. This saliva is the first of the digestive fluids.

The mucous membrane of the mouth is dotted over with minute tubules, called "buccal glands." These tubes are lined with extremely minute cells. The spittle or saliva is not a simple fluid. It consists of four distinct fluids. The buccal glands pour out a quantity of mucous, which mixes with the secretions which come from the *parotid*, *submaxillary*, and *sublingual* glands. The latter glands exist in pairs. Each parotid gland lies in front of the ear, and behind the angle of the jaw; and its duct opens into the mouth opposite the second grinder tooth of the upper jaw. The submaxillary glands and sublingual glands are placed in the floor of the mouth, and they pour their secretions into the mouth through two little openings which lie under the tip of the tongue, behind the front teeth of the lower jaw. These three glands swell up to a great size when a child has the mumps.

The saliva is a thin watery fluid, and contains in solution a small quantity of a remarkable substance called *ptyalin*, which possesses remarkable properties.

It does not affect in the least nitrogenous food or fats; but if mixed with starch and kept at a warm temperature, the saliva in time will convert starch into grape sugar. Starch is quite insoluble and useless as nourishment, but when acted on by saliva it becomes a highly soluble and nutritious form of sugar called grape sugar. How is this saliva manufactured? It is poured out to the extent of about 1½ lbs. in twenty-four hours.

The parotid and submaxillary glands and sublingual glands are good examples of what are called *racemose* glands. They are in general form like a small bunch of grapes. The main stalk represents the duct by which the secretion enters the mouth. The parotid gland consists of a great number of little sacs or bags, and each little bag is lined with a layer of extremely minute cells. Each little bag has on the outside of it an immense number of little bloodvessels. When the parotid gland is secreting its fluid, the little cells lining the bags or sacs imbibe from the blood circulating around them such material as they require, and they manufacture it into saliva. We cannot make them do this, nor can we prevent them forming saliva by any effort of our will. The mere presence of food in the mouth causes these little cells to begin their work. The smell of a delicious dish is sometimes sufficient to make them pour out their secretions, and then the mouth "waters," as we express it. The saliva formed in each little bag is poured out into the main duct or channel, and through this into the mouth. Thus during the chewing of food, spittle is being poured into the mouth by the buccal glands, by the parotid, submaxillary, and sublingual glands. When first poured out this saliva is alkaline. Besides acting on the starchy elements of food and converting them into soluble sugar, the saliva keeps the mouth constantly moist. It also dissolves sugar and salt, which form part of our food; and it also makes the chewed food slippery and easily swallowed.

It is important that you should know that these salivary glands are not active in the child until the age of four or six months. Hence to give a child of such an age much starchy food, such as arrowroot or corn flour, means to poison it. I have frequently seen children at this tender age suffering from diarrhœa and other troubles of the digestive system brought about by starchy food, which the poor child was quite unable to digest.

When the food is thoroughly chewed and mixed with saliva it is carried backwards by a semi-involuntary movement of the tongue, which at the same time presses down the epiglottis over the entrance into the windpipe, and the bolus of food is pushed into the commencement of the *œsophagus* or gullet, where, by the muscular action of the coats of the tube, it is carried down into the stomach.

Drink is taken in the same way. We must not suppose that the bolus of food and the gulps of water simply drop down from the back of the mouth into the stomach. This is not the case. Each mouthful is pushed backwards by the tongue, and then it is grasped by the muscular coats of the gullet and pushed down into the stomach. It is by means of this muscular action of the gullet that jugglers are able to eat and swallow food and drink while standing on their heads, and by this means the ox or the horse is able to drink water while its head is lower than its stomach.

THE GULLET.

The gullet or œsophagus is a tube about nine or ten inches in length. Above it is continuous with the *pharynx*, whose mucous membrane is continuous with that lining the back of the mouth. The gullet passes down immediately behind the windpipe, through the chest, and then passing through the diaphragm it at once becomes connected with the stomach near its large dilated cardiac end. I remember, when I was a boy, being told that a whale could not swallow a man, because its swallow or gullet was so small. It was supposed, because the whale fed upon small fish and extremely minute creatures in the sea, that therefore it must have a small gullet. It fell to my lot some years ago to dissect the large whale which, you may remember, was thrown on the shore at Longniddry and then towed across to Kirkcaldy, and I made a point of ascertaining the exact size of the gullet. Now, without giving you the exact figures, I may tell you that a man could pass down the whale's gullet just as easily as he could slip down the barrel of one of Sir William Armstrong's 100-ton guns! If the whale which was said to have swallowed Jonah was anything like the whale which I cut up, all I can say is Jonah must have had a very uncomfortable time of it, for in our whale's stomach there was about two tons weight of herrings and cod-fish, mixed up with no end of fish bones and several gallons of rancid oil. It is right, however, to say we are not told it was a whale that swallowed Jonah, but "a great fish." A whale is not a *fish* at all, but belongs to the class of animals to which man belongs. It is a mammal, and gives suck to its young one. No fish does that.

Every organ of digestion within the abdomen is invested by the *peritoneum*, a delicate membrane which lines the whole cavity of the abdomen, and then passes over every organ, giving a covering to each, and serving to bind them in their places.

THE STOMACH.

The stomach may be described as a large dilated tube, very like the bag of a bagpipe. One end of this dilated tube is much more blown out than the other end. This widely dilated part of the stomach is called the *cardiac* end, because it lies up against the under surface of the diaphragm, just under the heart. When the end of the stomach is full of wind the heart is often pressed upwards by it, and beats more powerfully against the chest wall, making a person believe he has some serious affection of the heart. The right end of the stomach gradually tapers off, and becomes continuous with the small intestine. Just before the stomach joins the intestine there is a valve, known as the *pyloric* valve, and the portion of the stomach near it is called the pyloric end of the stomach. The first part of the intestine in connection with the stomach is called the *duodenum*.

When the stomach is well filled it measures little more than twelve inches in length, and its greatest diameter is about five inches. If cut open and spread out like a handkerchief it would cover a space 1¼ feet square. The stomach does not lie straight across the upper part of the abdominal cavity. The bulged out cardiac end lies close against the under surface of the diaphragm on the left side, but the pyloric end of the stomach is situated much lower down on the right side, just below the margin of the ribs. From the lower border of the stomach there hangs down a beautiful membrane, known as the *omentum*, which serves as a protection to the coils of intestine which are beneath it.

Underneath the peritoneal coat of the stomach there are two muscular coats—an external and an internal muscular coat. The fibres of the external muscular coat run along from the cardiac end to the pyloric end of the stomach, while the internal muscular fibres wind round the stomach something like the hoops round a barrel. But the most wonderful part of the stomach is its mucous membrane.

The mucous membrane covering the tongue lines the back of the mouth, then passes down the gullet, then lines the whole of the stomach, and then lines the whole of the intestines. We doctors are continually looking at the tongue of our patients; why do we so? It is not to tell us how the tongue itself is, but to tell us how the mucous membrane of the stomach and intestines is. There is a wonderful sympathy between all parts of the mucous membrane, throughout the entire alimentary canal, and when one part is out of order, sooner or later the mucous membrane of the tongue will get out of order too; so by examining the tongue carefully we often can tell how the mucous membrane of the stomach and intestines is. I told you that the mucous membrane of the mouth was everywhere studded with buccal glands. So the mucous membrane of the stomach is everywhere studded with very remarkable tubular glands, whose duty it is to pour out the gastric juice during the digestion of food. When digestion of food is not going on the mucous membrane of the stomach is of a delicate pink colour, and is arranged in longitudinal folds; when the stomach is distended with food these folds disappear.

If we examine a portion of the mucous membrane of the stomach near its cardiac end with an ordinary lens or magnifying glass, we find that its surface presents a peculiar honeycombed appearance, produced by shallow, many sided depressions or pits. In the bottom of these pits are the openings of little tubes which lie side by side, and arranged in a perpendicular manner. Each little tube is lined by a great number of little cells, which have the power of abstracting from the bloodvessels which lie in the wall of the stomach the materials out of which they make the gastric juice. Each little tube has a number of minute bloodvessels round about it in close contact with it, so that the cells lining the tube can easily imbibe from the blood the materials they require.

GASTRIC JUICE.

These *peptic* glands, as they are called, when food is taken into the stomach, pour out a thin acid liquid called the *gastric juice*, which owes its acidity to the presence of hydrochloric or lactic acid. The gastric juice also contains a very remarkable substance known as *pepsin.* You remember that the cells lining the little sacs of the salivary glands poured out a thin liquid, which is alkaline, during the time the food is being chewed.

When food such as bread and meat, &c., is undergoing digestion in the stomach, the contractions of the muscular coats of the organ roll the food about, and at the same time the gastric juice is being constantly mixed with it.

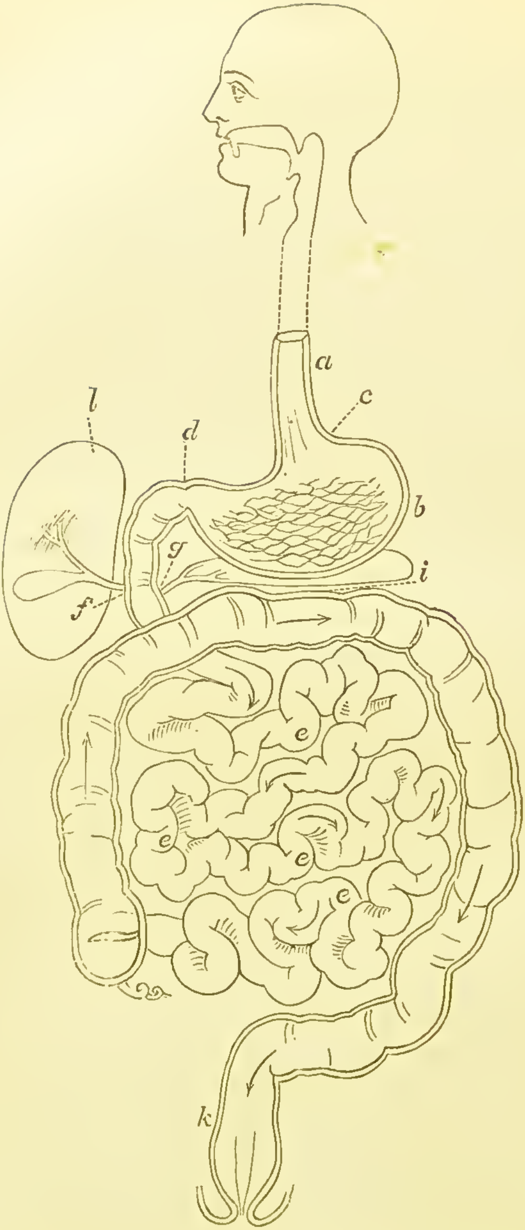
During the years 1825 to 1832, Dr Beaumont of the United States Army made a great number of observations on the process of digestion. He was fortunate in having a man exactly suited for his experiments. This man's name was Alexis St Martin. He was a Canadian boatman, who had an opening into the cardiac end of his stomach caused by the accidental discharge of a gun. The gun which shot St Martin was loaded with buck shot, and blew away a large piece of the wall of his chest, and made a big hole in the cardiac end of his stomach. This terrible wound healed, but there was left an opening in the skin, which communicated with the interior of the man's stomach. Dr Beaumont used to look into the man's stomach while digestion was going on; and he found out that gastric juice was poured out only when food was in the stomach. Immediately after food is introduced into the stomach, the delicate pale pink mucous membrane becomes red and turgid with blood, and there appear everywhere little minute drops of gastric juice, just like the drops of sweat on a man's brow. These drops gradually run together and flow down the wall of the stomach to soak into the substance of the food.

Dr Beaumont used to put a tube into the man's stomach, and suck out a quantity of the gastric juice, with which he experimented; and he found that if he mixed the juice with meat or white of egg in a glass, and kept it at the temperature of the body, it would digest these substances nearly as quickly as if it were in the stomach. He also used to tie pieces of different kinds of meat on a string, and then pop them into the man's stomach; at different times he pulled out the strings, and noticed how far digestion of the various meats had proceeded. As the result of such experiments, he found that tripe was digested at the end of one hour; roast beef at the end of three hours; roast mutton at the end of three hours and a half. Salt beef took four hours and a quarter, while roast pork took five hours to digest. He also told us that roast turkey was thoroughly digested at the end of two hours and a half. Not many of us get a chance of trying our digestions on roast turkey!

Now, gastric juice will not digest every kind of food. It affects only a single class of food, namely—the nitrogenous food, such as meat and albumen of white of egg, the gluten of bread, the casein of cheese, and such like. It has no effect on starch, or oils and fats; but solid and semi-solid nitrogenous foods are at once attacked and liquified by the gastric juice.

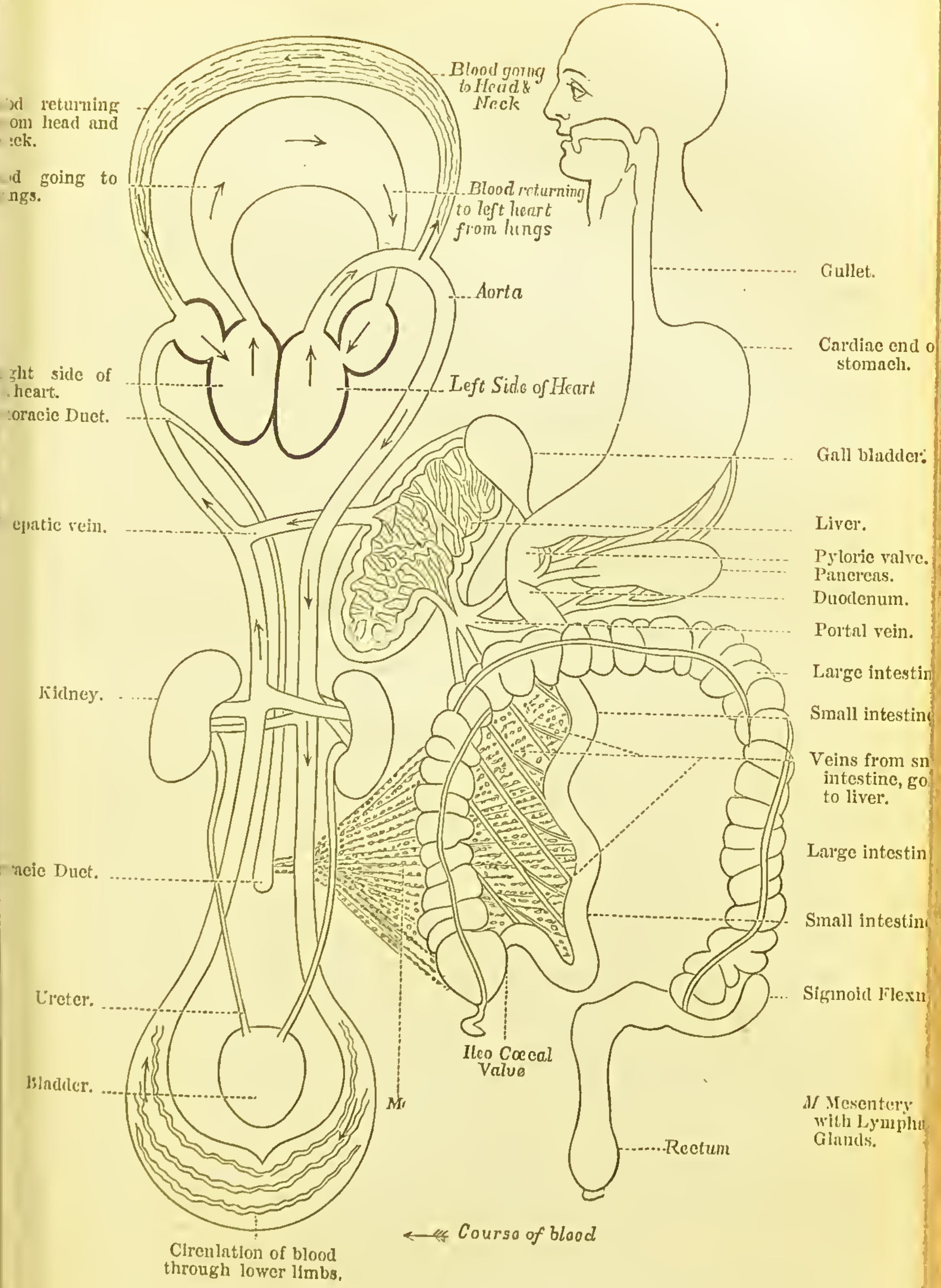
This power of digesting nitrogenous foods depends upon the presence of pepsin and acid in the gastric juice. The effect of digestion in the stomach is to convert the food into *chyme*, which is always a thick liquid, like gruel or thick pea soup, and has a strong disagreeable acid smell and taste. The quantity of gastric juice varies from 10 to 20 pints in twenty-four hours.

The real and important action of gastric juice is to convert the nitrogenous foods into such a state of solution that they can readily pass through the delicate walls of the bloodvessels in the walls of the stomach and intestines. All nitrogenous foods are converted into *peptones*. These peptones always contain nitrogen. When nitrogenous foods have been converted by the action of



Course of food indicated by Arrow.

Human Alimentary Canal.—*a* Œsophagus. *b* Stomach. *c* Cardiac orifice. *d* Pylorus. *e* Small intestine. *f* Biliary duct *g* Pancreatic duct. *h* Ascending colon. *i* Transverse colon. *j* Descending colon. *k* Rectum. *l* Liver. *p* Pancreas.


od returning om head and ck.
d going to ngs.
ght side of heart.
oracic Duct.
epatic vein.
Kidney.
acic Duct.
Ureter.
Bladder.
Circulation of blood through lower limbs.
Blood going to Head & Neck
Blood returning to left heart from lungs
Aorta
Left Side of Heart
Ileo Cœcal Valve
M
Course of blood
Rectum
Gullet.
Cardiac end o stomach.
Gall bladder.
Liver.
Pyloric valve.
Pancreas.
Duodenum.
Portal vein.
Large intesti
Small intestin
Veins from sn intestine, go to liver.
Large intestin
Small intestin
Sigmoid Flexu
M Mesentery with Lympha Glands.

gastric juice into peptones, the latter are easily absorbed into the blood, which they were not before being acted on by the gastric juice. Meat, eggs, milk, cheese, &c., are converted into soluble peptones.

Mixed up with the meat we eat there is always a lot of starchy food, such as exists in the potato and bread, and there is always some fat or oily matter in our ordinary diet. On these substances the gastric juice has not any action. They must be attacked and digested by other fluids before they can be absorbed.

Salt and sugar are dissolved by the gastric juice, and may pass at once with the soluble peptones into the bloodvessels in the walls of the stomach.

One remarkable character of the gastric juice, besides those mentioned, is, that it has the power of correcting and preventing putrefaction. Many men like game, "high," as it is called; such flesh is always in a state of putrefaction. The gastric juice corrects this, or else disease would result from eating such flesh. Such starchy material as was well digested by the saliva, along with sugar and salt, is rapidly absorbed by the bloodvessels of the stomach; but there is always a considerable quantity of starchy food that has escaped the action of the saliva.

Digestion of starchy food by the saliva in the stomach is put a stop to by the acid gastric juice, which renders the saliva powerless by neutralising it. All the time digestion is going on the pyloric end of the stomach is tightly closed, but towards the end of digestion the contractions of the stomach squeeze the chyme through the pyloric valve, and it then passes into the intestines. Only a small quantity of the soluble peptones are taken up by the bloodvessels of the stomach. A very large quantity of these rich nutritious peptones are taken up by the bloodvessels in the wall of the intestines, and from thence passed into the blood.

Man does not "chew his cud." I know a gentleman, however, at the present moment, who can bring up food from his stomach into his mouth at will, and chew it over again.

And now we have to consider what takes place after the digested food has passed out of the stomach into the intestines.

INTESTINES.

The first part of the intestinal tube is called the *duodenum.* It is about 10 inches in length. In man the intestinal canal is about 25 feet in length.

As a rule in flesh-eating animals it is short, and in vegetable-eating animals it is long. In the sheep it is 30 times the length of the animal itself, while in the giraffe the intestine is about 134 feet in length.

The length of the alimentary canal in grass-eating animals is probably owing to the low nutritious character of the food they eat.

The intestinal canal of man is divided into large and small intestines. These two are continuous with each other. The small intestine communicates with the large intestine by means of the *ileo-cœcal* valve, which allows the food to pass from the small intestine into the large intestine, but does not allow it to go in the opposite direction.

The intestinal tube, like the stomach, is covered over by the peritoneum. By means of this covering the coils of the small intestine hang down from the backbone into the cavity of the abdomen. The peritoneal membrane which thus supports the coil of the intestine is called the *mesentery.* It is a double layer, and between the folds are an immense number of bloodvessels, nerves, and lymphatic glands and vessels.

The intestinal canal, like the stomach, has four coats—the peritoneum, the external and internal muscular coats, and the mucous coats; all these structures are continuous with the similar structures of the stomach. The muscular fibres of the external coat run in the direction of the tube of the canal, while the fibres of the internal muscular coat surround the mucous membrane like the hoops of a barrel.

In the mucous membrane of the duodenum are numerous glands called the *glands of Brünner.* They are like little salivary glands, only very small, and they pour out a fluid which mixes with the chyme after it has passed through the pyloric valve of the stomach.

Throughout the entire mucous membrane of the small and large intestine there are imbedded an immense number of small tubes called the *follicles of Lieberkühn.* Each little tube is about the $\frac{1}{360}$ of an inch in diameter, and about five times as long as it is broad. These minute tubes are lined with extremely small cells, which pour out a peculiar fluid called intestinal juice, just in the same way as the glands of the stomach pour out the gastric juice. Now this intestinal juice has the wonderful power of acting on starchy foods in such a way as to convert them into soluble sugar, so that the starchy foods which escaped digestion in the mouth and stomach are now digested by the intestinal juice.

Perhaps the most important structures in the small intestine are the *villi.* On placing a small piece of the mucous membrane in a little water it will be seen to have a velvety appearance; this appearance is caused by the presence of an immense number of minute conical projections of the mucous membrane known as villi. These villi vary in size from the $\frac{1}{40}$th of an inch to the $\frac{1}{12}$th of an inch, but some are not more than the $\frac{1}{120}$th part of an inch in diameter. They cover the whole surface of the mucous membrane.

From the duodenum down to near the end of the small intestine the mucous membrane is arranged in transverse folds, which go nearly round the tube of the intestine. These folds are called *valvulæ conniventes.* They increase enormously the extent of the mucous surface, and as the villi cover the *valvulæ conniventes* as well as other parts of the mucous membrane, some idea may be formed of the great extent of surface there is in the small intestine. It has been calculated there are more than 4,000,000 villi on the surface of the mucous membrane of the small intestine.

The villi have a remarkable structure. Each contains a small artery which breaks up into many small veins, which end in one or more larger trunks, and then pass out of the villus again. In the middle part of the villus is a whitish-looking tube, called a lacteal vessel, which is an offshoot from an immense number of minute lacteal tubes imbedded in the submucous coat of the small intestine. As will be afterwards explained, the lacteal vessels absorb the fatty portions of food as they pass along the intestine.

The villi hang down from the intestinal mucous membrane, and as the food passes onwards they suck up the liquified portions of it with astonishing rapidity. The rapidity with which they absorb depends very much on the rapidity of the circulation of blood through the small bloodvessels in their interior. By the contraction of the muscular coats of the intestine, the digested food is squeezed onwards, and at the same time the villi are pressed against the passing food, and in this way they are better able to absorb the liquified portions of it. They absorb soluble peptones, soluble sugar, and a certain amount of emulsified fats and oils. The lacteals, however, absorb the greater proportion of the fats when digested. By this wonderful process of absorption the liquified and digested food is taken up by the minute bloodvessels in the villi, and then the veins in each villus convey blood saturated with nourishment into the larger veins which lie between the folds of the mesentery. These latter veins gradually converge upwards to a large vein called the *vena portæ*, which enters the liver at its under part.

At the end of the small intestine there remains little else but the indigestible portions of the food and the refuse of the intestinal secretions. These pass through the ileo-cœcal valve into the large intestine, where they are further acted on by the secretions from the large intestine, and anything that is nutritious is absorbed, while the rest is cast off from the body as useless material.

While the food is passing through the duodenum, it is mixed with the bile which comes from the liver, and with the fluid which is secreted by the pancreas.

THE PANCREAS.

The *pancreas* is a long, flattened gland, about eight inches in length, and one and a half broad, and nearly an inch in thickness. It lies right across the back bone in front of the large bloodvessel called the *aorta*, and its duct opens into the duodenum near its lower part. In structure it is like a salivary gland. The fluid secreted by the pancreas has the wonderful property of converting fats and oils into a complete emulsion, by which means they are readily absorbed by the lacteals of the villi, and by the small bloodvessels.

This power of emulsifying fats and oils depends on the presence of a peculiar substance, named *pancreatine*, in the pancreatic fluid. Pancreatic fluid also has the power of converting starch into grape sugar.

The Liver and Bile.

The *bile* mixes with the food in the duodenum just at the point where the pancreatic fluid was poured into the intestine. When freshly poured out, it is of a yellow or reddish colour. It has a strong, bitter taste, and it is neutral or slightly alkaline in its reaction.

The process of secreting bile is continually going on, but it is formed very slowly when one is fasting; when food is being digested, the bile is poured out in large quantity. The amount of bile poured out into the intestines varies according to the amount of food taken, but on an average there is secreted from 30 to 40 ounces in 24 hours.

The bile is formed in the liver by the liver cells. The liver itself weighs between 50 and 60 ounces. It is situated on the right side of the abdomen, and fits up against the under surface of the diaphragm on the right side, just as the cardiac end of the stomach fits up against the under surface of the diaphragm on the left side. It should not be felt below the margin of the ribs on the right side. It has a coat of peritoneum which binds it in its place.

It consists of an immense number of small *lobules* about the twentieth of an inch in diameter, which from mutual compressure have a polygonal shape. Now, each of these lobules consists of an immense number of minute cells, called hepatic or liver cells, whose duty it is to secrete the bile. They vary in size from the $\frac{1}{800}$th to the $\frac{1}{1000}$th of an inch in diameter, and from being pressed together they are polygonal in outline.

These little liver cells extract from the blood the material out of which bile is made, just as the cells in the peptic glands extract from the blood the material out of which the gastric juice is made. In each lobule there is an extraordinary capillary network of minute veins, which come from several branches or offshoots from the large vena portæ. Now you remember the vena portæ is the large trunk formed by the union of all the veins coming from the stomach, pancreas, and intestines. It is a large vein which enters into the liver on its under side, and conveys to the liver the blood which comes from all the organs of digestion, and this blood is loaded with the absorbed products of digestion.

This vena portæ gives off numerous small branches which pierce each lobule, and then split up into an extraordinary mesh of extremely small veins. In the mesh work thus formed lie the little liver cells. By this arrangement the liver cells are brought into close contact with the blood, as it flows through the minute veins; and they are thus better able to imbibe from the blood the materials they require to manufacture into bile.

After the bile has been manufactured from the blood by these little liver cells, it is passed into small vessels or tubes called hepatic or *bile ducts*, and these convey it to the bag called the gall or bile bladder, and in this bag it is stored up when digestion is not going on; but when digestion is going on, the bile is constantly poured out into the intestine, as I have described. But what becomes of the blood in the extraordinary mesh-work of veins after the liver cells have done their work? Why, in each lobule it is again collected into one small venous trunk, which leaves each lobule, and then joining a great number of other such trunks, all together form one large vein called the hepatic vein, whose duty it is to carry the blood thus deprived of the elements of bile into a large vein, the inferior vena cava as it is called, leading directly to the right side of the heart. From the right side of the heart the blood is pumped to the lungs to be further purified, where we shall leave it for a short time.

Please do not suppose that the bile is brought to the liver ready made and then extracted by the liver cells. It is not so. The blood which enters the liver by the portal vein contains no bile, but this fluid is entirely manufactured by the minute liver cells, in very much the same way as the other secreting cells in the different glands manufacture their secretions. It is indeed a wonderful process. In these liver cells lies the power of extracting such material as they require for the manufacture of bile. The bile is very rich in hydrocarbons—that is, substances composed of the elements hydrogen and carbon. Thus a piece of dried bile will readily burn away if lighted in a flame. As a rule no bile is to be found in the blood, but sometimes the mucous membrane of the duodenum in the neighbourhood of the gall bladder's orifice becomes swollen and inflamed. Then the duct of the gall bladder, which has a very small opening, gets blocked up, and the bile, somewhere behind the point of obstruction, is apt to be absorbed into the blood. When there is bile in the blood the white of the eye at once shows a yellow tinge, and the skin may become as yellow as a guinea. The person thus affected is then suffering from *jaundice.*

Now for what use is the bile? It is important to remember that it is poured into the intestine at its upper part, so that it mingles with the chyme directly after it leaves the stomach. Now this arrangement clearly shows that the bile has some important relation to the food with which it is mixed. There is little doubt that the bile is, in the first place, an excretion—that is to say, the bile is the means of purifying the blood coming from the organs of digestion. It takes from the blood a large quantity of impurities which, if they passed on into the general circulation, would be injurious to the body. The liver is placed as a filter between the organs of digestion and the right side of the heart, and without doubt, one of its chief duties is to filter the blood of those materials which collectively make the bile. But the bile, when once formed, has important digestive functions, of which the chief are—

1*st.* It assists in emulsifying the fatty portions of the food, and thus makes them more easily absorbed by the lacteals in the villi.

2*d.* By moistening the mucous membrane of the intestines the fatty matters of the food are more readily absorbed.

3d. It has a marked antiseptic power like the gastric juice. When thoroughly mixed with the food it prevents its decomposition, and the formation of gas in the intestine.

4th. As it passes down the intestine it seems to stimulate the follicles of Lieberkühn to pour out their secretions more copiously; and it also stimulates the muscular coats of the intestine to contract, and thus to drive inwards their contents.

After the bile has done its duty in assisting digestion, it undergoes some peculiar changes in composition, and is reabsorbed into the blood, and being a highly hydrocarbonaceous material it is oxidized, and by its combustion helps to maintain the heat of the blood.

But there is another wonderful function performed by the liver, and that is the formation of a substance which readily is converted into grape sugar. A Frenchman, Claude Bernard, 1848, after a number of experiments, found that a substance named "glycogen," or "sugar former," was manufactured in the liver cells, and that this substance rapidly became converted into sugar, and passed into the blood in the form of grape sugar, and by the oxidation of this sugar in the lungs the heat of the body is kept up.

This formation of glycogen in the liver is a normal process, and so is its rapid conversion into sugar. Sometime so much sugar is thus poured into the blood that some of it appears in the secretion from the kidneys, constituting the disease called "Glycosuria." The well-known disease *Diabetes mellitus*, in which a large quantity of sugar is daily found in the secretion from the kidneys, has some close relation to the normal glycogenic function of the liver.

Let me now, in conclusion, give a summary of the changes which take place in the food during its passage through the stomach and small intestine. In the stomach the food is thoroughly mixed and converted into a uniform mass. It is saturated with the gastric juice which dissolves the nitrogenous portions of it. The conversion of the starchy food into sugar, which began in the mouth, is now almost stopped in the stomach, and the fatty matters are thoroughly mixed up with the other constituents of food, but as yet they are not digested in the least. Soluble matters, such as sugar and salt, and those substances which have been rendered soluble by the action of saliva and the gastric juice, have begun to be absorbed by the bloodvessels in the wall of the stomach, and such fluids as wine and water also begin to disappear. That thick pea-soup liquid, the chyme, which results from the gastric digestion, is being continually squeezed through the pylorus into the duodenum. It consists of nitrogenous matters broken down and half dissolved, fatty matters broken down but not dissolved at all, starchy matters being slowly converted into sugar, and being dissolved in the fluids in which they are mixed as soon as they are converted into sugar. When it passes into the duodenum, the chyme is further mixed with fluid secreted by Brünner's and Lieberkühn's glands, and then with the bile and pancreatic juice. Now all these liquids have a more or less alkaline reaction, and by being mixed with the chyme the acidity of this latter becomes less and less, until, at the middle of the small intestine, it is decidedly alkaline in its reaction. In the upper part of the small intestine the fatty parts of the food are converted into an emulsion—that is, fat is converted into exceedingly minute particles, which are readily absorbed.

Those nitrogenous substances which were partly dissolved in the stomach are still further acted on by the gastric juice, and they are converted into soluble peptones, which are capable of easy absorption. The starchy constituents of the food are now rapidly acted on by the pancreatic and intestinal juices, and the sugar thus formed is quickly dissolved in the fluids, and is absorbed chiefly by the bloodvessels of the villi. The fatty emulsions are absorbed chiefly by the lacteals in the villi. As this fatty emulsion flows through the lacteals into the larger lacteal vessels it is called *chyle.* The epithelial cells covering the surface of the villi seem to pick up the minute fatty molecules and then pass them on into the lacteal vessels. The chyle flows in the lymphatic or lacteal vessels through the mesentery, and then is acted on by the lymphatic glands, which are very numerous in this situation. As the chyle leaves the mesenteric glands it is much altered in physical characters, and contains a number of corpuscles, which gradually pass into blood corpuscles.

The chyle at last passes into a long tube, called the *thoracic duct*, which leads into the large veins entering the right side of the heart. In this way the fatty emulsified foods are carried into the blood, and there they become saponified or converted into a soapy material, which diffuses thoroughly with the blood. Those nutritious substances which have been absorbed by the bloodvessels of the stomach and intestines pass in the veins up towards the liver, and as the blood, rich in nutriment, passes through the liver, bile is manufactured from it, and the blood is thus purified. The blood then passes into the inferior vena cava, and then into the heart, from whence it is pumped to the lungs. Here it is acted on by the oxygen of the air. A large quantity of carbonic acid and watery vapour is excreted, and the blood, rich in nourishment and purified, is now sent by the contractions of the left side of the heart all through the body. It flows from the large bloodvessels into the smaller ones, and then into the myriads of minute capillaries. Here the cells or ultimate structures of each tissue, such as bone, brain, muscle, &c., abstract or imbibe from the blood the materials they require for their nutrition, and for the performance of their functions. Thus the cells of the brain extract material from the blood, and there can be no doubt that if they did not get the material they require there would be no manifestations of mind. The muscles and bones and different organs of the body take only the materials they require. Recollect it is the minute cells in each tissue that select these materials, and that before they can do so the blood must be spread out into the millions of capillaries which permeate every tissue. While the blood is thus giving out nourishment for the nutrition and growth of the various tissues of the body, it also takes in the effete or used up material, the ashes, as it were, that remain after work has been done, and passing onwards loaded with impurities it arrives again at the lungs, where carbonic acid and moisture are again thrown off. It arrives at the skin, where much moisture and animal matters are thrown off, and as it circulates through the kidneys a large quantity of the effete nitrogenous materials is thrown off in the form of *urea*.

It is the minute cells in the different tissues and organs of the body that do all the work. They require to be well fed. The object of the circulation of the blood is to take nourishment to them, without which they could not work. All work implies waste. The circulating blood while it feeds the cells takes from them the waste materials. The waste materials consists chiefly of hydrogen and carbon. These are got rid of from the blood by breathing fresh air or oxygen, and by taking plenty of exercise, by which means an enormous quantity of carbonic acid gas, with moisture and animal matters, is thrown off from the blood.

In conclusion, compare the original germ or egg with man as we have now seen him. What a wonderful change. And yet every tissue of his body is made up of cells, which are the descendants of the original germ. Can you wonder at my endeavour this evening to fix your attention on the marvellous powers of these small cells? Do all you can to live strictly in accordance with the best rules of health. Try to preserve the lives of these little cells by living temperately, with due regard to exercise and cleanliness. And never forget that your life is made up of the lives of these little cells, and if they perish you perish also.

SMALL-POX AND VACCINATION.

By D. RUTHERFORD HALDANE, M.D., P.R.C.P.

We are all more or less painfully aware that we are subject to a variety of diseases, though the causes which give rise to them are often very obscure. Diseases do not occur spontaneously; if no morbific causes were in operation the organism might go on working smoothly until it was worn out, for I need not say that the body is only designed to have a limited duration. But as a machine is exposed to a variety of accidents which may affect its acting, and lead to its derangement, so the body is surrounded by causes of disease. If we had not a certain power of resisting these causes, we should be constantly ailing, and there are great differences in the power of resisting, not only between different individuals, but in the same individuals at different times. This greater or less power of resistance constitutes what is called the lesser or greater susceptibility to disease.

The causes of disease may be divided into two great heads, the general and the specific. The general causes are those which are constantly in operation around us, which do not act unless they are in a certain degree of intensity, and which often act rather by weakening the body and making it more susceptible, than by producing any definite disorder. Among these general causes we include age, sex, occupation and mode of life, climatic and atmospheric influences, and the like. As an illustration of the mode of action of these general causes, let me take a familiar example; what do we mean by catching cold? A person is said to have caught cold when, after exposure to a lowered temperature, combined usually with the chilling influence of air in motion, and often aided by a moist atmosphere, removal of heat from the surface of the body has taken place to an unusual degree, and when in consequence a disorder, trifling or severe, has been set up. Now it is not the cooling of the surface which is the direct cause of the disease, for the effects are not usually local, but show themselves in remote situations. Suppose several people sit in a draught; of these, a certain proportion, probably the majority, will escape altogether; of the rest, some may suffer from sore throat, earache, toothache, or rheumatism; others from feverishness, catarrh, pleurisy, or some other internal inflammation. It is evident that there has been nothing specific in the cause, for it has given rise to very different symptoms in different individuals. What has taken place appears to be this. When the skin is exposed to a sufficient degree of cold for a sufficient length of time, a peculiar impression is made on the nerves of the part, of which impression the individual may or may not be conscious; this impression is conveyed along the nerves to the centres in the brain and upper part of the spinal cord, and is then reflected, as it is called, along other nerves to various parts of the body. Now the effects will vary according to the susceptibility of the individual. If there is a susceptibility of his sensory nerves, this will show itself in rheumatic pains or neuralgia; if of the nerves of the bloodvessels and of nutrition, in various congestive or inflammatory affections; if the susceptibility be in the centre which regulates heat, fever may result. It will thus be seen that cold has not produced any uniform or specific effect; the effects upon different persons have varied according to their susceptibility, that is to say their greater or less power of resistance. The other general causes of disease act in essentially the same way.

With the specific causes of disease it is different. These are of the nature of poisons, and if they act at all, act always in the same way; the symptoms produced by them may vary in severity, but not in character. But there is one very remarkable peculiarity which distinguishes them from the ordinary poisons of the vegetable and mineral kingdoms. The effects of an ordinary poison depend essentially upon the amount introduced into the system, and they are in fact not poisons at all unless a certain minimum dose has been exceeded. Thus, many of the most energetic poisons, such as opium, arsenic, prussic acid, strychnia, and others, are in small doses most valuable medicines, and it is only when the dose is increased beyond a certain point that we get dangerous effects. As soon as a poison is introduced into the body, nature endeavours to eliminate it, and within certain limits will be successful in doing so; but if the quantity has been too large, the organism is overpowered, and death is the result. The specific animal poisons act in a different way; the amount of the poison taken into the system makes little or no difference on the effect produced, as the virus possesses the property of multiplying itself almost indefinitely. When an unprotected person is exposed to the poison of small-pox, he inhales a certain amount of air containing emanations from the sick person. The poison almost certainly exists in the form of very minute bodies floating in the air, so minute as to elude our most delicate means of research. At first no apparent effects are produced in the recipient of the poison; he may go about as usual; he may entirely forget his exposure to the disease; and it will not be until after an interval of ten or twelve days that he feels really ill. During this time, which is called the latent period, the poison has been going on multiplying within the system, and it is only when the development has proceeded to a certain extent that definite symptoms show themselves. Of the extent to which the poison has multiplied we can scarcely form an idea. The amount of the small-pox poison originally introduced was infinitesimally small, but in a bad case when the disease is at its height, the patient is covered from head to foot with countless pocks, from any one of which several persons might be inoculated; all his secretions are tainted; the atmosphere around him is teeming with the poison which is being constantly given off.

Another great peculiarity of these specific diseases is that one attack generally protects a person from the recurrence of the same disease. We know that comparatively few persons have small-pox, measles, scarlet fever, or hooping cough a second time. This is explained in the following way: in most persons there naturally exists in the blood a something which makes it a suitable soil for the multiplication of the poison; but when this multiplication has once taken place, that is when the person has gone through one attack of the disease, this something is destroyed, and unless it is again formed, which is always a tedious process, the person is insusceptible to a recurrence of that disease. You know in a general way what takes place in ordinary fermentation, such as the making of beer. The barley is first malted, and during the process a large quantity of sugar and starch is formed. The malt is ground or bruised, and by the action of warm water all the soluble matter is extracted. To this solution or wort, yeast is added, and very soon the fluid passes into a state of commotion or fermentation, much gas is given off, a large amount of new yeast is formed, and the sugar of the wort is converted into carbonic acid and alcohol. The process of fermentation comes to an end so soon as all the sugar has been so converted, and it is evident that it could not be again set agoing unless a fresh quantity of sugar were added. Yeast, I may state, is a substance in a state of change, containing an immense number of microscopic vegetable cells, which are undergoing rapid growth. When the yeast is introduced into the wort, the growth of cells goes on more rapidly, for their development is an essential part of the process. After a time this cell growth reaches a climax, then declines, and at last dies out. All this is very analogous to what occurs in the case of the specific poisons; there exists in the blood something analogous to the sugar in the fermentable fluid ; the poison corresponds to the yeast and multiplies within the body until the whole of *the something* has been destroyed or converted ; and when this has once taken place it can only be renewed, if ever, after the lapse of a long time.

The last peculiarity I shall mention with regard to the specific diseases is, that each of them is produced by a special poison, that they are propagated by infection or contagion, and that so far as we know the poison is never spontaneously produced; that is to say, while the vast majority of diseases such as inflammations and the like may be produced by a variety of causes, small-pox and the other specific diseases can only be produced by the communication of the poison from the sick to the healthy. It is often difficult or impossible to trace the communication, but when it is borne in mind that the poison exists in an almost impalpable form, and that it may under certain circumstances retain its properties for an almost indefinite period, our difficulties with regard to exceptional cases will disappear.

I fear I have wearied you by these somewhat abstract considerations, but I hope they may prove conducive to the better understanding of the proper subject of my lecture, upon which I now proceed to enter.

Of the specific diseases of which I have been speaking, small-pox is the most important, although fortunately its ravages are far more limited than they were prior to the introduction of protective measures. It seems quite unnecessary for me to give any description of the disease, but I have no doubt you are all aware that it is one of the most dangerous and loathsome maladies which afflict mankind. Of the origin of small-pox we know little or nothing; it appears, however, to have come from the East, and to have been known in China and Hindostan from time immemorial. It is said that in India, long before the Christian Era, a particular goddess had been worshipped as a protectress against it. The disease slowly travelled westwards, for communication was very tardy in those days, and it seems to have reached Constantinople by way of Egypt about the year 569, the year of the birth of Mahomet. From Constantinople it spread gradually over the whole of Europe, having reached England about the middle of the thirteenth century, while Sweden was not visited till two hundred years later.

In Europe small-pox long constituted one of the greatest scourges of the inhabitants, and in the present day we can have no idea of the terror with which it was regarded. It was more dreaded than the Plague, and the treatment of the disease previous to the time of the great English physician Sydenham, was not calculated to diminish the mortality. The treatment consisted in endeavouring to "drive out the poison," in encouraging perspiration by enveloping the patient in thick flannel, in carefully excluding every breath of fresh air, and in the administration of hot drinks.

In the eighteenth century, when the population was much smaller than at present, it is calculated that 500,000 died of it in Europe annually. In France the annual mortality was 80,000; in England, 7 to 9 per cent. of all deaths were attributable to it. A good illustration of the prevalence of small-pox is afforded by a proverb well known at that period, "From small-pox and love, but few remain free."

The ravages of the disease were still more terrible when it was for the first time introduced into a new country, especially if that country were within the tropics. Small-pox was unknown in America at the time of its discovery by Columbus in the year 1492; it was introduced by the Spaniards, and first showed itself in Mexico in 1527, and is said to have cut off at that time three millions and a half of the inhabitants. Thence it gradually overran the whole of America. It is believed that nearly one-half of the North American Indians were cut off by it; powerful tribes were almost exterminated. Perhaps a still better idea of the malignancy of the disease may be obtained by observing how many deaths it caused among the royal families of Europe, who, it is reasonable to believe, were surrounded by all known precautions against it. Joseph the First of Austria and Mary Queen of England died of it; and in the course of the eighteenth century it cut off two empresses, six archdukes and archduchesses, an Elector of Saxony, and the last Elector of Bavaria.

When the terror regarding small-pox was at its height, news came to this country that in Turkey a means was known for moderating the severity of the disease. This means was inoculation, and consisted in taking a little of the small-pox matter on the point of a needle and introducing it below the skin. The result was that the disease was communicated to the person inoculated, though generally in a very mild form. This operation seems to have been practised from time immemorial in China and India, and to have slowly travelled westwards till it reached the shores of the Levant and Turkey.

Early in the last century the news of this discovery first reached England; a description of it was given by several medical men, but at first no attention was paid to it. It was to Lady Mary Wortley Montague that her countrymen were indebted for having introduced this practice into England. Lady Mary had accompanied her husband to Turkey, where he was ambassador, and she there heard of the process for the first time. Small-pox was a disease which she had good reason to dread; her only brother had been cut off by it, and she herself had had a severe attack, so much so, that it was thought she would be permanently disfigured. Though this did not happen, the disease left tokens of its passage, for it deprived her of her very fine eyelashes; a deprivation, it is said, which gave a fierceness to her eyes which impaired their beauty. She watched the Turkish process with peculiar interest, and was so satisfied by what she saw and heard that she had her only son, a child of three years old, inoculated in 1718. The operation was quite successful, and from a letter of Lady Mary to a friend, written shortly before, I may be allowed to make the following quotation:—"I am going to tell you a thing that I am sure will make you wish yourself here. The small-pox, so fatal and so general among us, is here entirely harmless, by the invention of *ingrafting*, which is the term they give it. There is a set of old women, who make it their business to perform the operation every autumn, in the month of September, when the great heat is abated. People send to one another to know if any of their family has a mind to have the small-pox; they make parties for this purpose, and when they are met (commonly fifteen or sixteen together), the old woman comes with a nut-shell full of the matter of the best sort of small-pox, and asks what veins you please to have opened. She immediately rips open that you offer to her with a large needle (which gives you no more pain than a common scratch), and puts into the vein as much venom as can lie upon the head of her needle, and after binds up the wound with a hollow bit of shell; and in this manner opens four or five veins. The children or young patients play together all the rest of the day, and are in perfect health to the eighth. Then the fever begins to seize them, and they keep their beds two days, very seldom three. They have very rarely above twenty or thirty pocks in their faces, which never mark; and in eight days' time they are as well as before their illness. Every year thousands undergo this operation; and the French Ambassador says, pleasantly, that they take the small-pox here by way of diversion, as they take the waters in other countries. There is no example of any one that has died in it; and you may believe I am very well satisfied of the safety of the experiment, since I intend to try it on my dear little son."

Lady Mary returned home in 1721, and her daughter was the first person ever inoculated in England. In the course of the following year the Princess of Wales had her two daughters, the Princesses Amelia and Caroline, inoculated, after the process had been successfully tried upon six condemned criminals in Newgate. There was a special reason for the anxiety of the Royal Family with regard to small-pox. Queen Mary, wife of William the Third, died in 1694 of malignant small-pox at the age of thirty-two, to the intense grief of her husband, and the profound sorrow of the nation. In 1721, George the First had recently come to the throne, and the direct succession of the Hanoverian line was of the utmost importance to the Court and to the nation. Queen Mary's death had made a deep impression, which had not subsided after the lapse of five-and-twenty years. Inoculation, introduced into England under such favourable auspices, gradually spread, and was doubtless the means of saving many lives.

We are not, however, to suppose that the new system was allowed to spread unopposed. Far from it; it was denounced as dangerous, precarious, immoral, and irreligious. It was said to be acting in opposition to Providence, by attempting to take the progress of events out of higher hands. It was declared to be unprotestant, because it had come from Turkey. Though opposed both by the medical profession and by the clergy, it was among the latter that its bitterest opponents were found. The Rev. Mr Massey preached a sermon against it in St Andrews, Holburn, in which, to quote the words of a contemporary writer, having selected his text from the book of Job, he inveighed against the dangerous and sinful practice of inoculation, treated the inoculators with the most unqualified abuse, calling them diabolical sorcerers, hellish poisoners, enemies of mankind, and expressed the hope that they would be distinguished from those of the medical faculty who deserve honour, and not be permitted to mingle with them, as the devil among the sons of God. He considered inoculation to be a very ancient art, and to have first been put in practice upon Job by the devil, who, by some venomous infusion into the body of Job, had raised his blood to such a ferment that it threw out a confluence of inflammatory pimples all over him from head to foot, and that truly he had conveyed it to him by the way of inoculation.

Gradually, however, prejudices were got the better of, and the practice of inoculation became pretty general among the upper and middle classes, with the effect of rendering small-pox much milder among those who were submitted to the operation. Whereas formerly about one in every five cases of small-pox died, the mortality among the inoculated was not greater than one in fifty. How it is that inoculation produces a mild form of small-pox we do not know. You will have observed that the essential peculiarity in regard to it is that the small-pox poison is introduced directly into the blood, instead of entering the system by the lungs or some other channel. Now, as a rule, medicines or poisons act more energetically when introduced directly into the blood than when swallowed, and you may have heard of a new mode of administering active medicines by what is called subcutaneous injection. When this method is employed, a smaller dose is required, and the medicine acts more rapidly; but in the case of inoculation, the direct introduction of small-pox matter into the blood, contrary to all analogy, diminishes the virulence of the poison. But a great objection to inoculation was soon discovered. It had been hoped that small-pox induced by it would not be infectious, but it was soon found that this was not the case, and consequently the effect was to disseminate small-pox throughout the country more widely than before. Previous to inoculation, epidemics of small-pox only occurred occasionally, the disease almost disappearing in the intervals; but now every inoculated person became a new centre of contagion, and those who were not inoculated were actually in greater danger than before. The process of inoculation could never have become general, and it appears from evidence laid before Parliament, that though it was a great protection to those on whom it was performed, it was a great source of danger to others, so that on the whole the total mortality had been rather increased than diminished by it. It appears that just before the introduction of vaccination, when inoculation was as general as it was ever likely to become, the annual mortality from small-pox in the United Kingdom was 36,000. Accordingly, in the year 1840, inoculation was made illegal by Act of Parliament.

We now come to vaccination, the discovery of which will for ever be associated with the name of Edward Jenner. Jenner was born in the vicarage of Berkeley in Gloucestershire, on the 17th of May 1749. The little town of Berkeley, in the centre of the vale of the same name, is situated near the Severn, in one of the richest pastoral districts of England, which produces the well-known double Gloucester cheese. Jenner was educated in his native village, and in due time was apprenticed to a surgeon in Bristol. He appears to have been of an inquiring disposition, and to have early shown a predilection for Natural History. In this great dairy district it was a matter of frequent observation that those engaged in milking were occasionally subject to sores on their hands similar to those which were found upon the udders of the cows. There was also a popular superstition, for it cannot be called anything more, that those who suffered from this eruption thereby obtained a protection against small-pox, at that time the most fatal and the most dreaded of diseases, but no attempt had been made to investigate the matter any farther. While still an apprentice Jenner had heard of this popular opinion, and it seems at once to have made an impression upon him. At this time, however, he had no opportunity for prosecuting his inquiries, and when, after a residence in London, he returned and settled in his native place, he found that there were great difficulties in the way of his investigations. He persevered, however, and about thirty years afterwards his inquiries resulted in the full establishment of vaccination. Now this was no accidental discovery. Others had heard the opinion of the milkers but had paid no attention to it; Jenner himself had mentioned it to some of his friends, among whom he ranked several of the most distinguished men of his day, but they seem to have at first looked upon him as an amiable enthusiast. It must be remembered that there were very serious difficulties to be overcome. Jenner soon found that the cows were often free from disease, and it was then impossible to make any experiments; he then found that the cows were subject to several eruptions which were communicable to the milkers, but that only one of these afforded a protection against small-pox; he next discovered that when the true disease was present the matter required to be taken from the pustule at a particular period; and finally, he made the brilliant discovery that it was not necessary that the protecting material should be taken directly from the cow, but that it could, without impairment of its virtue, be passed on from one human being to another. Most discoveries have had, or are believed to have had, in them something of the romance of accident. Newton is said to have been led to his grand discovery by seeing an apple fall from a tree, while he sat meditating in his garden; Watt is supposed to have first had his attention directed to the expansive power of steam, by noticing on a winter evening the lid of a tea-kettle raised by the vapour of the boiling water. It would be as unjust to say that the discovery of gravitation or of the steam-engine was accidental, as to deny to Jenner the full merit of having worked out his great discovery of vaccination in a thoroughly scientific manner.

In June 1798 Jenner's researches were made public, and from that time we may date the establishment of vaccination.

It was not to be expected or even desired that the announcement of a discovery which bade fair to revolutionise a whole department of medicine, should be received without opposition. We have seen that in the case of inoculation the clergy were its bitterest opponents, but on the introduction of vaccination its warmest enemies were members of the medical profession. We know what a powerful motive self-interest is, and on the announcement of vaccination it was not surprising if the self-interest of the medical profession took alarm. In those days small-pox was no inconsiderable source of revenue to the Faculty, not only to the physician but to the surgeon; for while the former claimed the treatment of small-pox as being an internal disease, on the latter the duty of inoculation, and not unfrequently the subsequent management of the case, devolved; and when the craft by which we have our wealth is in danger, all are ready to cry out with the silversmiths of old, "Great is Diana of the Ephesians." On the whole, however, the reception which vaccination met with is, I consider, very creditable to the medical profession; a few at first bitterly opposed it, but the great mass of practitioners, as soon as they were satisfied of its value, became its warm supporters.

As I have quoted some of the arguments of the clergy against inoculation, it is only fair that I should give you some specimens of what was said by medical practitioners in opposition to vaccination. The argument upon which most weight was at first laid was, that vaccination being derived from the cow, introduced into the human system new and bestial diseases. Thus it was gravely maintained that diseases previously confined to the bovine race had been communicated by means of vaccination. It was asserted that cow-pox, mange evil, abscess, blotches, beastly ulcers, and other diseases of brute beasts, had been incorporated with the human constitution. These statements were not confined to vague generalities, numerous specific instances were appealed to. Everybody might have heard of William Ince, who, it was asserted, had become since his vaccination covered with patches of hair like a cow. There was a little girl, Polly Ringrose, who, poor thing, was not only becoming hairy all over, but coughed like a cow, and squinted as only cows squint. There was Miss Mary Ann Lewis, the cow-poxed, cow-manged young lady, and Master Jowles, the cow-poxed, ox-faced boy. Above all there was an unfortunate child at Peckham, whose naturally fine disposition had become brutal, who went about upon all fours, bellowing like a cow, and butting with his head like a bull.

Such assertions in the present day seem simply ridiculous, but they had their weight at the time, and had no doubt some effect in retarding the early progress of vaccination. I have no doubt that the objections still brought forward against vaccination, will at no distant date be considered as frivolous as these. It is a remarkable fact that the opposition to vaccination was more violent in England, where it was discovered, than in any other country. No doubt this was owing to the political freedom of Great Britain, which permits empiricism and many species of imposture to flourish, which are either restrained or suppressed by the more rigid laws of other states. Perhaps, as Dr Moore, one of the historians of vaccination, observes, "the facility for controlling such evils and of punishing knaves is some compensation for the loss of the blessing of liberty."

What the precise relation is which vaccine matter bears to small-pox, we do not altogether know. We know that the cow is subject to a local eruptive disease, which when introduced into man constitutes vaccinia, and is protective against small-pox; and we know that the inoculation of human small-pox lymph into cows produces vaccinia, but that human small-pox and cow-pox are identical, though highly probable, cannot be said to be altogether proved. This much, however, is certain, that the two are closely allied, and the practical point is that by vaccination we substitute a mild and local for a virulent constitutional disorder.

In spite of all that has been said by its opponents, no unprejudiced person can doubt as to the efficacy and value of vaccination. In countries where it has been introduced and systematically carried out, the number, the intensity, and the extent of small-pox epidemics have been remarkably diminished, and in a manner which makes the idea of mere coincidence utterly inadmissible. One fact is a sufficient illustration of this. In London alone, during the eighteenth century, the annual mortality from small-pox was from 3000 to 4000. In the ten years 1845 to 1854, when the population was enormously increased, the average annual mortality was about 340, and if vaccination had always been properly attended to, it would have been even smaller. At its first introduction, when the fear of small-pox was strong, vaccination was very generally taken advantage of, but as the pestilence was kept in check persons became indifferent, and the protective means was often neglected. I may mention that it was not til

1853 that vaccination was made compulsory in England, and not till 1864 that this provision was extended to Scotland. By the law as it now stands, every parent must have his child vaccinated within six calendar months of its birth, and the vaccination must be repeated until successful, unless the child be found to be insusceptible. Another circumstance which proves the protective power of vaccination is that where the vaccination of adults, as in the Prussian army, has been regularly performed, epidemics of small-pox no longer occur. The trial of re-vaccination in that army has conclusively demonstrated the efficacy of the measure, to test which we have merely to compare the immunity of soldiers during epidemics of small-pox with the mortality in classes of the same general age in the civil community, among whom re-vaccination is not systematically carried out.

Another advantage obtained from vaccination is, that it not only saves many lives, but that it prevents much weakness, suffering, and deformity. Small-pox is not only directly dangerous to life, it is very apt to be followed by troublesome consequences or sequelæ. Of persons who suffered from the natural small-pox a considerable number remained permanently debilitated, never regaining their former strength. If any scrofulous or consumptive tendency existed, it was very likely to be called into activity. Another risk was permanent loss of sight or of hearing, particularly of the former. Inflammation in small-pox very often attacks the eyes, and permanent blindness is frequently the result. Few children are born blind; in the great majority of cases blindness is due to the destruction of the eyes by inflammation in early life. Before the introduction of vaccination the great proportion of the blind had lost their sight in infancy in consequence of small-pox. It was calculated in the last century that three-fourths of the cases of blindness in blind asylums were due to small-pox. From this danger effectual vaccination is an almost absolute protection. Finally, small-pox was formerly very much dreaded, in consequence of the permanent marking which a severe attack of the disease left behind it. Unfortunately, such cases are still occasionally met with; but in the days of our great-grandfathers there were comparatively few families in which some pretty face had not been made plain, some fine complexion destroyed.

Lady Mary Wortley Montague, to whom I have already referred, was not only a very beautiful, but a very clever woman. During the course of her life she wrote a good many poems which have since been collected, and have had a tolerably wide circulation. Among these is one entitled "The Small-pox," in which a lady, who is convalescent from that disease, describes her feelings on looking into her glass for the first time. From this I may be allowed to quote a few lines :—

"The wretched Flavia, on her couch reclin'd,
Thus breath'd the anguish of a wounded mind,
A glass revers'd in her right hand she bore,
For now she shunn'd the face she sought before.
'How am I chang'd! alas! how am I grown
A frightful spectre to myself unknown!
Where's my complexion? where my radiant bloom,
That promis'd happiness for years to come?
Then with what pleasure I this face survey'd!
To look once more my visits oft delay'd!
Charm'd with the view, a fresher red would rise,
And a new life shot sparkling from my eyes!
'Ah! faithless glass, my wonted bloom restore;
Alas! I rave, that bloom is now no more!
The greatest good the gods on men bestow,
Ev'n youth itself to me is useless now.

. . . .

Ye cruel chemists, what withheld your aid?
Could no pomatum save a trembling maid?
How false and trifling is that art ye boast!
No art can give me back my beauty lost.

. . . .

Galen, the grave, officious squirt was there,
With fruitless grief and unavailing care;
Machaon too, the great Machaon, known
By his red cloak, and his superior frown;
And why, he cried, this grief and this despair?
You shall again be well, again be fair;
Believe my oath (with that an oath he swore);
False was his oath; my beauty was no more!

. . . . .

Adieu ! ye parks—in some obscure recess,
Where gentle streams will weep at my distress,
Where no false friend will in my grief take part,
And mourn my ruin with a joyful heart ;
There let me live in some deserted place,
There hide in shades this lost inglorious face.
Plays, operas, circles, I no more must view !
My toilette, patches, all the world adieu !' "

The last benefit conferred by vaccination is that it gives us the means of getting rid of small-pox altogether. Small-pox, as I have already said, differs from most diseases in this, that it is only propagated by contagion ; it never, so far as we know, arises anew. Various fevers and other diseases are produced by overcrowding, bad drainage, and other general causes, but small-pox never seems to be produced in this way. All we know of its history shows that it has always been imported. It came to us from the East, and we can trace its importation into America in 1527, about thirty-five years after its discovery. It was unknown in Australia and New Zealand for many years after their discovery, and is said to have been imported into the former country by the steamship the *Great Britain.* Now if every one were protected by efficient vaccination small-pox could no longer spread, as no one would be susceptible of the poison, and thus the disease might in course of time be literally stamped out.

In spite of the incalculable benefits which have been conferred by vaccination, there is still a certain number of persons who oppose it on various grounds, and Anti-Vaccination Societies have been established with a view to influencing the legislature to cease to render vaccination compulsory. As this lecture is not intended to be of a controversial character, I shall refer to the objections in the briefest possible manner.

The grounds on which vaccination is opposed are various. In the first place, it is said to be unnatural, and even irreligious, to introduce a disease into the system with the object of protecting it from a malady to which it may never be exposed. The answer is simple : before the introduction of vaccination small-pox was almost always more or less epidemic; and as we have seen, the most exalted rank afforded no immunity from its attacks; and were vaccination discontinued this state of matters would soon be restored. As to being unnatural: our life is now so artificial that it is difficult to say what we do that *is* natural. It is unnatural to wear clothes, to cook our food, or to avail ourselves of the services of the lower animals for purposes of transport or locomotion; but are not these unnatural actions the very proofs of advancing civilization? There is in man an irresistible impulse to rise above the condition of the savage; and it is this very instinct which distinguishes him from the beasts of the field. There is, however, such a spirit of contradiction inherent in some minds, that there is probably no discovery which has not been objected to on the ground that it is unnatural or injurious. I suppose there are few who will deny that a certain amount of good has been done by the medical profession; yet there is a class of the community who style themselves, I believe, the peculiar people, one of whose tenets is that it is morally wrong to apply for medical assistance, and that the treatment of disease should consist exclusively in prayer, anointing with oil, and laying on of hands. I remember very well when chloroform was first introduced, that it was strongly objected to on the ground that it was wrong to abolish pain, that in surgical operations pain was beneficial, and that to prevent it would be hazardous to the patient. I wonder if any of these objectors ever showed his sincerity by declining on these grounds to take chloroform when he was having a tooth extracted, or a whitlow opened.

Another argument brought forward against vaccination is that it is dangerous, that it is the cause of skin diseases, and that in many cases it is even the direct cause of death. Scrofula and consumption are cited as amongst the chief diseases which may be directly transmitted to healthy children by means of vaccine lymph. If, however, due caution be used in vaccinating, if the operation be not performed upon too young, feeble, or sickly children, not during the time of teething, nor at very unfavourable seasons, the bad results will be found to be so extremely rare, that in comparison with the advantages attained, they will appear of trivial importance. Of course when I speak of vaccination, I suppose it to have been carried out in the best manner, for there can be no doubt that bad results may follow when the operation has been carelessly performed. This leads me to say a few words regarding the precautions to be attended to in the performing of vaccination. Of course I do not enter into particulars which concern the operator; I only make one or two general suggestions.

In the first place, except in very pressing cases, children should only be vaccinated when they are in good health. The existence of any acute or chronic disease, or particularly of any skin affection, will almost certainly interfere with the course of vaccination. No doubt there are circumstances, as when small-pox is epidemic, which may render it imperative to perform the operation, notwithstanding the existence of contra-indications.

In the next place, the child should be vaccinated in early infancy. One-fourth of the total mortality in England from small-pox occurs in children under the age of one year; and hence the great risk of delay. Healthy children living in large towns should be vaccinated when about three months old; in more delicate children it may be postponed for a month or two; but all, except those whose health positively contra-indicates it, should be vaccinated before the age of six months. Finally, the lymph used in vaccinating should be taken from healthy children, from healthy vesicles, and a sufficient number of punctures should be made. As, however, these are points with which every vaccinator is supposed to be familiar, I need not farther insist upon them. I may mention, however, that the various Licensing Bodies now require that every one of their licentiates shall have received special instruction in the performance of vaccination, and shall have obtained a certificate of his competence to perform it.

The last point I have to consider is the protective power of vaccination. It may be stated generally that persons who have once been successfully vaccinated are, as a rule, permanently protected against small-pox. A certain proportion will, however, be liable at some period of their lives to take the disease a second time, generally in a mild and modified form, though occasionally severe and even fatal cases occur. You are aware that one attack of scarlet fever, measles, or hooping-cough usually protects from a recurrence of these diseases. Exceptions, however, do occur, and every now and then we have instances of second, or very rarely of third, attacks of these diseases. Now vaccination, with its subsequent phenomena, may be looked upon as a very mild attack of small-pox; and it is not surprising that after a certain period the protective influence should sometimes wear out, and susceptibility return, though usually in a very trifling degree. An attack of natural small-pox usually, but not invariably, protects against a recurrence. I remember, when I had charge of the Small-pox Hospital, having a patient with a severe form of the disease, where the pocks of the second attack were actually situated on the pits of the first. As such exceptional cases occur after the natural disease, they occur with still greater frequency after vaccination; and hence arises the question of the propriety of re-vaccination. By many this practice is only considered necessary when there has been some defect in the primary vaccination, as indicated by the imperfect character of the scar or cicatrix; but there can be no doubt that it is very valuable, by extinguishing the renewed susceptibility to small-pox which may gradually arise. I believe it, therefore, to be a very proper precaution that every one should be re-vaccinated between fourteen and sixteen years of age. In a great many it does not "take," as it is called, and this merely indicates that the susceptibility to the disease has not returned; while in a considerable proportion it takes as perfectly, or nearly as perfectly, as in the infant. When re-vaccination has succeeded, it is, I believe, quite unnecessary to repeat it; but if it have not, it may be performed again a few years later, particularly if an epidemic of small-pox has broken out, or if the individual should be about to proceed to a warm climate, which appears to have the effect of increasing the susceptibility.

Were vaccination and re-vaccination properly attended to, small-pox might, as I have already said, be stamped out; but although this very desirable consummation is theoretically possible, I am afraid it will never be arrived at practically. Prejudice, ignorance, and indifference are too formidable enemies to be ever entirely got the better of, and we must, I fear, be satisfied if we confine the ravages of the disease within the narrowest possible limits.

Before concluding, I may be permitted to make a few observations as to what may, in the future, be expected of medicine in the prevention of disease, more particularly of these epidemic diseases which contribute so largely to the annual mortality. Till lately it was considered that the sole duty of the physician was to cure disease, but very erroneous ideas were entertained as to what disease really was. Diseases were formerly looked upon as new and independent entities, but now we look upon them as perversions of natural or physiological processes. Formerly, when an inflammation manifested itself, it was regarded as something superimposed upon the organism; as an enemy attacking the fortress of life, which required to be repulsed by the most energetic measures. Its supplies must be cut off by the enforcement of a rigorous diet, and it must be attacked with the heavy artillery of bleeding, mercury, and blisters. But it was not kept in mind that by these measures the garrison was weakened in an equal degree with the enemy, or rather in a greater degree, so that even if the adversary were overcome or retired from the contest, the patient often succumbed owing rather to the severity of the treatment than to the malignancy of the disease. Now, however, we look upon inflammation and other diseases in a different light; we view them as perversions of normal states, induced by the operation of some external or internal agency. We endeavour, therefore, to put the part or the system in the most favourable circumstances for the resumption of its physiological condition. By the adoption of this rational treatment, a very considerable diminution in the mortality of disease has taken place.

But of late years it has been recognised that the physician has another duty to perform. It is not enough that he interferes when disease has manifested itself; he is called upon to show how it may be prevented from occurring. And it must be borne in mind that this preventive office is even more important than the curative. Disease, when fairly established, is often incurable; or, if the more urgent symptoms are removed, it frequently leaves behind it a permanent weakness or debility. As there is never a battle in which the conquerors do not suffer more or less severely, there is never an attack of illness which does not leave the body weaker than it found it. It is only lately that the fulfilment of the duty of preventing disease has become partially possible, because it is only lately that any definite knowledge has been obtained regarding the causes of these diseases. Within my own recollection two of the most important fevers, typhus, and typhoid or enteric fever, were confounded together, and of course their causes were unknown. I do not say that even now their causes are thoroughly understood, for there is still a difference of opinion as to whether or not they should be included among the specific diseases. It is, however, now well ascertained that whereas typhus fever is caused by, or at least is closely associated with destitution and the crowding together of human beings, typhoid fever is due to bad drainage and the emanations from decaying excrementitious matter. The physician has proved this, and so far has performed his part; it remains for the sanitary authorities to carry out his suggestions, and to banish these diseases from our midst. Considerable improvements have been effected, so far as typhus is concerned, by piercing new streets through densely populated localities, and by preventing overcrowding in dwelling-houses, but in the case of typhoid fever we cannot say even this. There can be no doubt that bad drainage is worse than no drainage at all, and, unfortunately, our drainage and other sanitary appliances are often defective, both in their design and in their execution. We constantly hear of typhoid fever appearing among the inhabitants of new houses; now this is absolutely unpardonable, as showing that the drainage arrangements have been badly planned, or that their execution has been carelessly carried out. And this state of things will continue until the authorities insist that a strict supervision be exercised on the construction of all new tenements, and that when constructed this supervision be renewed from time to time.

With regard to the more strictly specific diseases, I have, I trust, shown you how vaccination has robbed small-pox of its terrors, and there is strong reason to hope that the same result may be arrived at in the case of measles and scarlet fever. The poison of these diseases, as in the case of small-pox, doubtless consists of infinitely minute bodies, which float about in the air, and which, when introduced into the bodies of unprotected individuals, lead to the development of these diseases. Now it is in the highest degree probable that we may succeed in rendering these poisons practically innocuous. We are led to believe this by knowing what has already been done in the case of a disease which bears a close analogy to them. There is a very deadly malady to which some of the lower animals are subject, called splenic fever. It has been known for some time that in the blood of animals dying of this disease there are very minute foreign bodies of a vegetable nature which have the power of almost indefinite multiplication. It was then shown that these bodies could be cultivated in fluids outside the body, and that they formed germs which could remain long inactive, but which, under suitable conditions, could grow and multiply. Then followed the brilliant discovery that by cultivation this fungus could be so modified that when innoculated into animals it only produced a mild attack of the disease, but that this protected the animals from subsequent attacks, even when exposed to the poison in its most malignant forms. There can, I think, be little doubt that by means of experiment it will yet be shown that the poison of measles and scarlet fever may be modified in a similar manner, and that, as in the case of small-pox, these diseases may be deprived of the greater part of their malignancy.

In bringing this lecture to a conclusion, I have only a single remark to make. Of late years the advances of medicine have been very rapid in every one of its departments, and everything leads us to believe that they will be still more rapid in the future. We can never expect to get rid of disease altogether, for susceptibility to disease is a law of our nature. It cannot be expected that medicine shall ever take rank with the exact sciences, for where we have to deal with the phenomena of life, vitality introduces a disturbing element, which we can never expect to get the better of; but we may safely look forward to a period when we shall be enabled to undertake a more equal struggle with disease, —a period when the success of the physician shall be more nearly than at present on a level with his good intentions.

A COLD:

What it means; its possible consequences; and how it is to be avoided.

BY JAMES O. AFFLECK, M.D.

MR CHAIRMAN, LADIES, AND GENTLEMEN,—The subject of this evening's lecture was suggested to me by the Committee of the Health Society, and, although left free to make choice of other subjects, I did not feel disposed to depart from their selection, seeing that the topic is one of general concern and much practical importance. It had, besides, this additional recommendation to me, namely, that the manner of handling it was indicated in the terms stated on the programme. I have accordingly undertaken to address you on the subject of A Cold; what it means; its possible consequences; and how it is to be avoided.

Instead of attempting at the outset to define precisely the common expression "a cold," of which most of us already possess some notion derived from personal experience, I shall at once proceed to consider the first part of the subject, viz., WHAT A COLD MEANS, and this will, of course, involve in a general way its definition.

Among the many ideas which we are wont to associate with life, and which vary in accordance with our moods or currents of thought at particular times, whereby we liken it to a journey, a race, a conflict, a dream, &c., there are few more appropriate, or more constantly applicable, than that which views it as a condition of defence or resistance. In point of fact, however, this view is something more than a mere idea, it is an actual attribute of life. It could be easily shewn to be true of life in its social, intellectual, and moral aspects, but it concerns us here to deal with life in its physical manifestations; and whether we regard these as displayed in plants or in animals, we shall find that there are always in operation processes, which, while serving many other ends, such as growth and nutrition, at the same time effectually secure the organism from the action of hurtful influences, that would, if left to exercise their effects unresisted, infallibly accomplish its destruction. While this general principle is equally true in the case of man, it is to be observed that the conditions of his existence are affected by civilization and by his surroundings, and therefore, that besides these natural processes of defence, he must have recourse to his intelligence to devise additional means for his protection. And yet we know that, notwithstanding all that can be done in this way, the enemy gains but too ready access to him, and works havoc in his frame, nay, that even many things calculated to minister to his comfort and well being, become under certain circumstances the means of his hurt or even of his ruin. Among the agencies of this kind which may be productive of good or of evil, there are few of such consequence as the atmosphere in which man lives and breathes. Who does not feel how much of health and comfort depends on the state of that element? Its purity is essential to respiration, and on its condition as to temperature hang important issues of life. Now it is with the relation of our bodies to the temperature of the atmosphere, and with its influence upon them, that we have at this time specially to do; but before we proceed further in the discussion of this subject, we must consider for a little in what way our physical frames are acted on by the coldness or warmth of the surrounding air. This again will render necessary my making, in the first place, some general remarks upon the subject of the sources of that animal heat which all of us who are in health feel we possess. This heat, then, is derived not from without, but from within our bodies, where it is generated as one of the results of changes which are constantly going on in the processes of nutrition—in the wasting and building up again of our tissues. Every organ or member of the body in the performance of its function expends part of its substance—it wastes—but if the body be in health, and due nutriment supplied, this is immediately repaired; and in this process, which is very much a process of combustion, heat to a greater or less amount is generated. This statement is true in an especial manner of our muscular system, the part of our structure which is most universally and constantly in a state of activity. Thus the generation of heat is one of the necessary properties and accompaniments of animal life—inseparable from it; and when life ceases the animal heat departs and cannot be revived. You cannot warm a dead body any more than you can reanimate it.

But the heat thus generated does not in health accumulate within us,* but is always being given off from our bodies in various ways. Thus part of it is given off by the lungs, for the air we breathe out is warmed by it; part of it is given off by the skin, from which it radiates into the surrounding atmosphere, or is conducted away by cooler bodies, or is given out in the form of perspiration. Besides this, others of the natural channels of the body carry away a certain amount. It is thus evident that in the living body there is a manufacture and an expenditure of heat constantly going on. Notwithstanding this the heat of our bodies in health is a tolerably uniform quantity (98°—99° F.) whatever be the temperature of the surrounding atmosphere, and any material deviation from this betokens some departure from health. It might interest you to hear of the extremes of temperature which the human body can bear with impunity. As regards cold, the experience of Arctic voyagers is remarkable. Thus Capt. Sir John Franklin recorded a cold of − 58 or 90° below freezing point; Capt. Back, − 70 or 102° below freezing point; and more recently Capt. Sir George Nares, in his interesting account of his voyage to the Polar Seas, describes his experience, in March 1876, of the extraordinary temperature of 73·75 or more than 105° below freezing point. It is difficult for us, even with the experience of our most severe winters, to conceive of this amount of cold. Capt. Nares states that the very "whisky froze hard, and a few of us had the rare opportunity of eating it in a solid state." The health of the crews kept good even in this terrible cold. "Fortunately," adds Capt. Nares, "these extremely low temperatures never occur with a high wind, or no human being could possibly endure the weather." As regards heat, in many parts of the tropics, there is a daily temperature of considerably over 100° F., but a much greater amount than this can be borne for a limited time without injury. Experiments were made on the subject about a century ago by Drs Fordyce and Blagden, who found they could remain for a considerable time in a chamber heated to 260°, and it is well known that certain workmen, such as those in sculptors' foundries, have to go into chambers where the floor is red hot and the air heated to 300° or 400°. If we bear in mind that in such extremes alike of cold and heat, the temperature of the body remains unaltered to any appreciable extent from its natural standard (98°—99°) it follows that there must be some defensive power or arrangement possessed by our bodies which enables them to withstand the evil effects we should naturally expect to arise; in short, that there must be some means or adjustment for regulating our bodily temperature and keeping it at a uniform point. And such an arrangement does exist, and is in fact simply that process of the giving off of heat to which I have already referred. We saw that every muscular effort implies an increased waste of tissue, and therefore an increased production of heat. When we exercise our muscles vigorously, such as in active walking movements or manual labour, and thus generate much heat within us, how is it that we get rid of the overplus above the normal amount? Chiefly by the lungs and skin. The very activity makes us breathe faster, and therefore more heat passes away from us in this manner, while at the same time the blood is driven to the surface of the body and circulates in increased amount in the skin, which thus becomes the agency, by the processes of radiation, conduction, and perspiration, of drawing off a very large amount of warmth. In this way the increase and loss of heat are equalised. Again in the case of the action on our bodies of extreme cold the same result is brought about, as we shall afterwards see, by a sort of reverse process. We shall also find that the nervous system is largely concerned in controlling all these natural operations. Now these statements regarding the heat regulation of our bodies, and the chief factors concerned therein, are of the utmost importance in relation to the subject in hand, for it is by some disturbance in this physiological equilibrium, if I may so express it, that the morbid effects of cold are induced.

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* It has been estimated that if this heat were allowed to accumulate within us, and none to be given off, it would be sufficient to raise the body to the boiling point in thirty-six hours.

Let us then inquire for a moment what are the effects on the body of cold when it is left free to exercise its hurtful action. The tendency of extreme cold is to the depression of all the vital functions, an effect which it exerts apparently through the agency of the nervous system. Death from exposure to cold is happily a comparatively rare occurrence in this country, and yet never a winter passes without some instances of it. In the severe winter of last year the number of deaths from this cause was exceptionally large all over the kingdom. In such cases the sufferer, after prolonged exposure, in which much animal heat is lost, sinks into a lethargic state, in which the functions of respiration and circulation speedily cease, the fatal event being hastened if the person has been long without food, or is in a state of intoxication. The effects of cold on the functions of the nervous system were never more strikingly displayed than among the soldiers of the First Napoleon in the disastrous retreat from Moscow in 1812, when we are told some of them became mad, many were seized with convulsions, others staggered about as if intoxicated, and sank into a stupor from which they could not be aroused.

Short of such extreme results, other evils, essentially the same in nature, though differing in degree and in their subsequent effects, are capable of being produced by cold. These may be either local, or general in the system. As an illustration of the former, there is the condition known as frost-bite, of which the familiar chilblain is but a mild form. Here, some exposed part of the body is subjected to the action of extreme cold; it becomes pale and dead looking, and unless the circulation be quickly restored, does actually perish by a destructive process of inflammation. The cold has altered the normal nutrition of the part, has lowered its vitality, to such an extent as to cause this inflammation to arise in and around it. This may be considered a direct local effect. But apart from this, and far more frequently, there are other effects which are to be regarded as secondary consequences of the depressing action of the cold on the general system, particularly the nervous system, and which are shown in lowered vitality and subsequent inflammatory action in some part or organ. Let me explain. The nutrition of every portion of the body, to the most minute tissue, is under the direct influence and control of the nervous system, as is proved by the fact that anything which interrupts or interferes with the communication between a part and its nervous connections, will affect the health or soundness of that part. I cannot at present stop to inquire how this nervous influence is exercised, but you may just bear the fact in mind. The nervous system, which, as you know, embraces the brain, spinal cord, sympathetic, &c., and the numberless branches of nerves which ramify everywhere throughout the body, and in no place more abundantly than in the skin, is so arranged that an impression made at one point, and conveyed from thence to the spinal cord or brain, may there excite either the same or else a new set of impressions or actions, which may be conducted to another and far distant point. It is in some respects like the very useful system now in operation of what is called the "telephonic exchange." A number of individuals have telephonic wires leading from their houses or places of business to a common central office. If then A, living in the west end, wishes to communicate with B, living in Leith, he cannot do so directly, but he sends a message to the central office to say, "put me in communication with B," whereupon his wire is switched on to connection with B's wire, and the two can then converse with each other. Now to apply this to the subject in hand, an impression of a depressing kind is made upon some part of the surface of the body, say the feet, the chest, or neck, by cold or damp. It is conveyed to the brain, which sends it off again, not necessarily to the part or organ from whence it came, but to some other one altogether. The message the brain sends is that for the time the healthy nutrition of the part is to be altered or disturbed, and, as a consequence, some mischief, generally in the form of an inflammation, more or less severe, must result. This, I take it, is very much what happens when we catch a cold.

What determines the locality of the body where the effect is to appear is beyond our power to explain. Why, for example, it should happen that of three persons exposed to the same amount of cold, one should take a rheumatic fever, another a simple cold in the head, and the third perhaps be entirely unaffected, we cannot positively say. It may be, however, that in each individual there are certain parts and tissues of the body which, from constitutional causes, inherited or otherwise, or from previous diseased action in them, are more vulnerable than others. We know that there are parts which, from their situation, their functions, or their relations to other organs (such as the relation of the lungs and the kidneys to the skin), are easily excited to inflammatory action, as the result of a chill to the surface of the body.

These points, then, enable us to settle the question what the term " a cold " means. It means, or rather ought to be understood as meaning, an inflammation of some portion of the body brought about by the direct or indirect action of a lowered temperature. Popularly, of course, the term has a more restricted meaning, and is generally used in reference to an irritation of the respiratory passages, or, as it is technically called, a catarrh, about which I have something to say under the second division of my subject.

Meanwhile, having tried to show what the *nature* of the process is, it may be useful to consider for a moment *how we take cold.* It may be stated generally that we take a cold by some cause which makes us part too suddenly and too abundantly with our natural animal heat, in fact by our becoming chilled. While we are in health our bodies may, as we have seen, sustain cold of extreme degrees unhurt, but even then certain conditions are necessary, such as that food be sufficiently supplied, that exercise be taken, and that adequate protection by clothing be afforded—conditions, however, which when observed, not only enable us to bear cold with impunity, but cause it to excite in us that pleasant glow which proves it to be a source of strength and exhilaration.

But let these conditions be wanting, and then the case is totally altered. If our health be depressed from any cause, or if we have had insufficient food, we feel the cold air take hold on us in a way that is the reverse of comfortable. Or again, if we are long exposed to a low temperature, and are compelled to remain in a state of inaction, we quickly lose our animal heat, and are unable to replace it in adequate measure, and so become more or less thoroughly chilled. Thus it is that we suffer when in cold weather we sit in rooms without fires, or go into places of resort which happen to be imperfectly heated. Our heat is radiated away into the cooler air around, and we readily catch a cold. All the more surely will this take place if our clothing be thin, or of such a kind as offers but a feeble impediment to this heat radiation. Sudden alternations of temperature too, such as in leaving a warm apartment and facing a cold wind, particularly if the body be perspiring, produce a like result, by disturbing the natural heat-equilibrium already described. Further, when cold is accompanied with moisture its chilling effect upon the surface is intensified, and we all know that there is no more certain way of catching a cold than by exposure to a damp atmosphere of low temperature, or by getting wet through. It should ever be borne in mind that the power of resisting cold even in health is much less at the extremes of life than at any other period, and that therefore children and old persons alike part with their animal heat and suffer from the effects of this in a very marked degree.

It is evident, then, that it is in most instances by impressions made upon our skin that we take cold. This wonderful vesture of our bodies is not only, as has already been told you in previous lectures, of prime importance as an organ of elimination of waste matters, but it is equally so as a medium of conduction in relation to the temperature within our systems and that outside of us. It is not a good conductor, and well for us that it is not, otherwise we should be liable to be hurt far oftener and far worse than we are. This comparatively negative power as regards conduction it is that in great measure prevents our suffering from the sudden and frequent changes in the temperature of the air around us, as it no less prevents our losing too quickly or too abundantly the heat within us. But in addition to this, we possess in the function of the skin, if it be in health, an arrangement which may be regarded as constituting our first line of defence against the hurtful influence of extremes of temperature. No sooner does a cold blast impinge upon us than the skin, richly provided as you already know, with bloodvessels and nerves, contracts, and we often observe the surface roughened with little points in consequence of this contraction. In thus contracting its bloodvessels become emptied of their blood, and its heat-radiating and evaporating function is for the time arrested, while the body goes on accumulating heat sufficient to furnish a reaction when the cold is withdrawn, or before it. This reaction or glow is one of the best indications that we have not been injured by the cold. But this salutary process operates within comparatively narrow limits, and is conditioned by so many circumstances, that it too often proves inoperative. Thus it may happen that the vitality of the skin is weak from natural delicacy, or from neglect to maintain it in a healthy condition, and so it will fail to contract vigorously or remain contracted till a glow can be established in time to prevent mischief, and the same thing will happen even in a healthy skin, if the cold be too severe and too long continued. The result of this will be a too rapid withdrawal of heat from within, and an impression made upon the nervous system which will be transmitted to some part or organ, and produce in it the morbid effect of cold, viz., inflammation. It would seem, however, in such instances that before matters proceed to this extent there is often an effort of nature to keep the enemy, which has now got within the lines, from advancing to the citadel. What, for example, causes us to shiver when we leave our homes and go out into the cold air of a winter night, or what is the meaning of our sneezing vigorously when exposed to a cold draught? It would seem probable that these acts stimulate the depressed nervous system to increased resisting power, and in this way tend to ward off the full effect of the action of cold. Moreover they in a peremptory way call our attention to the matter, and lead us to join the efforts of our will in keeping off the enemy. The statement that "the man who resolves not to take a cold seldom does," * although it may seem to you a strong one has nevertheless much

* *Lancet*, 29th November 1879.

truth in it, for not only does he brace himself up to exert a strong mental resistance when he feels himself threatened, but he almost instinctively resorts to some physical means to prevent his being chilled, and to bring himself aglow, such as by quickening his pace, or other vigorous and steady movement, and in this, if he be in health, he will generally succeed. Some of you may remember the graphic description by Cowper in the "Task" of the country labourer driving home his team in a stormy winter evening:—

"He, formed to bear
The pelting brunt of the tempestuous night,
With half shut eyes, and puckered cheeks, and teeth
Presented bare against the storm, plods on.
* * * *
O happy! and in my account, denied
That sensibility of pain with which
Refinement is endued, thrice happy thou!
Thy frame, robust and hardy, feels indeed
The piercing cold, but feels it unimpaired.
The learn'd finger never need explore
Thy vig'rous pulse; and the unhealthful east
That breathes the spleen, and searches every bone
Of the infirm, is wholesome air to thee."

Unhappily, however, we are not all made of such stout material, and in our modern ways of living any of us—even the strongest—may catch a cold, whether we resolve or no. Indeed it would seem that many of our colds come upon us by stealth, and we are often unable to say how we have contracted them. I must now, however, leave this the first part of our subject, but before doing so let me in a word summarise the points I desire you to bear in mind respecting the nature of a cold.

1. That our bodily heat depends not on clothing nor on anything external to us, but upon active changes going on within us in the processes of nutrition.

2. That during life this heat-generation is always going on, while at the same time there is a giving off of heat from our bodies, chiefly by the lungs and skin, and that the due adjustment of this heat-production and heat-discharge maintains the

body at its normal standard of temperature, 98°—99° F., irrespective of that of the surrounding air.

3. That extreme cold by removing our bodily heat tends to exercise a depressing effect upon our nervous system, but that in health this effect is resisted up to a certain point by the protection afforded by clothing, but more especially by the defensive and reacting power of our skin.

4. That when this defence is broken down, either by too prolonged exposure, ill health, want of food, insufficient clothing, &c., a morbid impression is made upon our nerves and brain, which is conveyed from thence to some part or organ of the body, and produces an alteration in its nutrition, which finds expression in the form of inflammation either slight, as in the case of a simple catarrh, or of more grave and serious character; and that all this is included in the term "a cold."

II. We have now to consider the second part of our subject, viz., THE POSSIBLE CONSEQUENCES OF A COLD. It will, I think, be obvious even to those possessing no medical knowledge at all, that this expression cannot be taken in a literal sense, for in disease, as in everything else, the contemplation of possibilities might exercise our minds for a whole lifetime. I must therefore limit myself to a reference to the chief possible consequences of the taking of a cold as these are ordinarily presented to medical experience, and even this restricted view will not, in the time at our disposal, admit of anything beyond the most general remark.

It may be said with truth that there is no disease to which the human body is liable that may not be seriously influenced by the effects of cold, but while this is true it is also the case that certain ailments are affected in a very special manner by this cause, while many others undoubtedly owe their origin to it. The catching of a cold will not indeed bring on any of the specific fevers such as scarlet, typhus, or typhoid, or the other so called "zymotic" or infectious maladies, each of which is primarily due to the reception into the system of a particular disease-poison or germ. But while this is the case it is no less true that the taking of a cold exercises a very important influence in relation to this class of ailments. Thus it will by its depressing action render us more liable to receive the contagion of them if we are thrown in the way of it. But this influence of cold is shown chiefly by the extent to which it aggravates the severity, and increases the mortality, of almost all those complaints I have mentioned, by inducing complications and results which are often far more serious than the original disease. This is strikingly the case as regards the infectious diseases of childhood, such as measles, hooping cough, and scarlet fever. Simple enough ailments in themselves in the vast majority of cases, they become, chiefly by reason of their complications (which are principally inflammatory affections of the lungs or kidneys), the causes of a terrible destruction of infant life, and are justly looked upon as the scourges of our families. These complications no doubt belong to, or form part of, the disease, and may appear despite the greatest care; but it is unquestionable that in a large proportion of instances they are justly to be ascribed to the influence of cold, the tables of mortality of the Registrar-General showing how largely the death-rate from these diseases is increased in the colder months of the year, or when the temperature is low. I may be allowed to add my own confirmation of this, as the result of observations in the Fever Wards of the Royal Infirmary for a number of years past. But the evil is not to be measured alone by the extent of the mortality, for such complications, even if recovered from, but too often lay the foundation for future bad health, and careful medical enquiry can often trace back some disease occurring in later life to its origin in connection with one of the disorders of childhood. This is a fact which parents and those in charge of children would do well to ponder, and the practical lesson it conveys as to the exercise of the utmost care and watchfulness needs no enforcing.

Rheumatism is another malady upon which the influence of cold is exhibited in a marked degree. Doubtless a rheumatic constitution is in many persons an unfortunate inheritance, but whether connected with this or not, the acute form of the disease, that which goes by the name of rheumatic fever, is in almost all instances traceable to a chill of the surface of the body produced by getting wet through, by long exposure to a cold wind, or by sudden arrest by cold of perspiration. This painful complaint is a common ailment of early life, particularly in our climate, and is ever to be looked upon as a serious one, not so much from any immediate danger (though even that is not inconsiderable) as from its tendency to induce disease of the heart. Every physician knows how large is the number of cases of heart disease that owe their origin to acute rheumatism in youth, brought on as the result of a cold, and it is sad to reflect how much suffering and death are thus due to causes in great measure preventible. But not alone in its relation to heart disease is the evil effect of rheumatisms made evident. The disease once occurring tends to return, and to bring about alterations in the joints which render many a strong man stiff and infirm long before his time, to say nothing of aches and pains which afflict him on every change in the weather, and add so seriously to the burden of life.

On no part of the human body does cold tell with more severe and deadly effect than upon the organs of respiration. The deaths in this country from diseases affecting these organs far outnumber those from any other class of ailments.* The respiratory tract commences at the nostrils, extends back into the throat, down into the windpipe, then into the bronchial tubes, which lead into the lungs, which latter organs are invested by a thin delicate membrane called the pleura. The inner passage, that is from the nostrils to the lungs, is lined throughout with a thin membrane called the mucous membrane. It is easily excited to inflammation, and is the part which suffers most when we take a cold in the head or chest. It is not, however, by breathing in cold air,

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* This in Scotland in the year 1877 (according to the most recent annual report of the Registrar-General), out of the total number of deaths,

viz., - - - - - - - -		73,937
The deaths from diseases of the respiratory organs (chiefly bronchitis and inflammation of the lungs) numbered - - -	14,249	
And from consumption alone - - -	8,342	
	22,591	

Or 1 out of about 3·3 deaths is due to diseases affecting the respiratory organs over this membrane if it be in a healthy state, that we catch a cold, but in the way I have already tried to explain, by a chill to the surface of the skin making an impression on its nerves, which is conveyed to the brain, and from thence reflected back upon, or telephoned to, some other part. Now it appears to be this very part that is in most frequent telephonic communication with the brain upon the subject of a cold, partly no doubt from its exposure to vicissitudes of temperature rendering it more susceptible, but no doubt also from its intimate physiological relationship to the skin.

Let us look for a moment at the effects of a cold on the various parts of this respiratory tract, bearing in mind that usually only a portion of it is affected at one time, although it may spread on to another part. The effect is, as I have already stated, to produce an inflammation of the mucous membrane, which causes at first swelling and then some discharge from the surface, both of which will impede more or less the free passage of air into and out of the lungs, and affect the breathing according to the part of the tract where the disease is located. Thus when it is confined to the first part, viz., the nose, we experience those symptoms characterising a cold in the head, with which we are all familiar, and which, though very unpleasant, particularly on lying down, does not seriously interfere with breathing, since we have in the mouth a supplementary channel for the entrance and exit of our breath. But let us pass a little further on, say into the windpipe, and here the effect of a cold is a very much more serious affair. At this part the channel for the passage of air is very narrow, and there is no supplementary one, so that when it becomes narrower by swelling, or inflammatory deposits on its surface, a formidable mechanical impediment is presented to the breathing, and there is risk of suffocation. This is the state of things in croup, and constitutes the danger of this malady. Let us now inquire how a cold affects the branches of this windpipe, or the bronchial tubes as they are called, the channels leading directly into the lungs. You will notice that these tubes differ in size, being larger as they pass off from the trunk, *i.e.*, the windpipe, and smaller as they branch away towards the lungs, the ultimate ones being exceedingly minute, and ending in the air cells of the lungs, where they convey the pure air breathed in to the blood, which requires this for carrying on the functions of life. Well, when inflammation attacks these bronchial tubes there is produced that common disease (one of the most common) bronchitis. This is one of the most serious of complaints, and its gravity depends on the extent to which the inflammation spreads throughout this bronchial tree, whether both sides are affected, and whether it involves the larger or the smaller branches. There is always more or less obstruction to breathing in bronchitis, as well as cough and expectoration, and general illness; but more particularly is this the case when the disease is located in the smaller branches. This is the form it is apt to assume in young children, and a very fatal form it is. Thus in Scotland in 1877, of the total number of deaths from bronchitis, viz., 9182, no fewer than 4305 occurred in children under three years of age. It is also extremely fatal to old persons. But apart from its fatal effects, bronchitis is liable to recur and become chronic, leading to changes affecting both lungs and heart, which occasion prolonged bad health, and ultimately terminate life. More deaths occur in this country from bronchitis than from any one disease, and bronchitis, bear in mind, usually begins by a simple cold. But again, a cold may attack the lungs themselves and produce inflammation in them, or acute pneumonia, or, as it is now often but erroneously termed, congestion of the lungs. The effect is to produce a hardening or solidifying of their natural spongy texture, and to cause great embarrassment of breathing. This is always a serious malady, but if uncomplicated and in a previously healthy and temperate person, usually runs a favourable course. Then, either along with pneumonia, or apart from it, the outer covering of the lung—the pleura—is often excited to inflammation by cold and damp, and that painful complaint pleurisy is the result. In severe cases of this disease an effusion of fluid collects outside the lung and compresses it, rendering it unable to expand to admit air in breathing, and unless this fluid be drawn off or otherwise removed by treatment, imperilling life or entailing serious permanent consequences to the lung and function of respiration.

But beyond all those ailments I have named, in importance is the relation of cold to the production of pulmonary consumption. This disease derives, as you know, its melancholy interest from the fact that it marks specially out as its victims those who, having passed out of childhood's dawn, are in "life's gay morn," with its bright future of promise and anticipation, when the very idea of suffering and dying is, and ought to be, as unwelcome as it is unnatural. How often has the fire of Genius been quenched by the rude blast of this Angel of Death, while as yet it was scarce aglow, and all that survived to a sorrowing age were some treasured fragments of a brief life's work—a sad but imperishable witness to greatness, the beginnings only of which could be achieved, and to virtue that had blossomed but to die! Who among us has not lost a friend, or it may, alas! be one dearer to us than friend, by this dire malady. Have we not often known it devastate a family; removing one, and another, and another, till all were gone. Is it not in every sense of the word truly named consumption?

Now that this malady shows a tendency to run in families is admitted on all hands; but such hereditary influence has probably been greatly overrated, for assuredly in large numbers of instances it cannot be established, and in them the disease must be regarded as acquired. It does not now concern us what is the proportion between these two categories. It is sufficient to know that apart altogether from any hereditary predisposition, consumption may show itself in any one,—in the strong, well-built, and hardy, no less than in the feeble, narrow-chested, and ill-developed. It would lead me too far into the field of purely medical discussion were I to bring under notice all the different factors concerned in the production of consumption, but it may be safely affirmed that in a very large proportion of all forms of this disease one of the principal of these is the taking of a cold or a series of colds. The history of many a sad case of this kind is often very much the following:—A young man (the same quite as often happens in the case of a young girl) catches a cold, to which perhaps he is rather liable. He thinks little about it, and it does not give him much trouble, except that he coughs occasionally, particularly on lying down at night, and on rising in the morning. He does not look very ill, or it may be is even congratulated on looking fresh and ruddy. But the cough still goes on, for weeks, or it may be for months, and he is at length noticed to be getting thinner. His friends, feeling some uneasiness, persuade him, rather against his will, to seek medical advice. Then is brought to light the real state of matters, and it is found that already he is in the grasp of this dread disease. Who so truly as the physician can realise and appreciate the pathetic language of Henry Kirke White, himself a sufferer from it, in addressing this "most fatal of Pandora's train."

"Oft I've beheld thee in the glow of youth,
  Hid 'neath the blushing roses which there bloom'd,
And dropt a tear, for then thy cankering tooth
  I knew would never stay till, all consum'd,
  In the cold vault of death he were entomb'd."

Now it is in the commencing stage of this disease, while as yet it has many of the characters of a common cold, producing a form of inflammation of the lung, that much may be done by treatment to arrest and remove it, and it is unhappily just in this very stage that it is so apt to be disregarded, upon which there follow the too common results in the wasting of the lungs and the break-down of the whole system. I am far from asserting that this disease, consumption, is not amenable to treatment, and even in a sense to cure, in all but its very latest stages, and our resources are far more abundant and more potent for this than they were when Kirke White wrote; but certain it is that the chance for life and for recovery is immensely greater the earlier the set-down cold is recognised and dealt with. I do not wish to dilate upon this painful topic, except to say that it is from this disease, beyond all others, that the admonition comes with solemn emphasis, *Do not neglect a common cold.*

Disorders of many other parts of the body might be easily cited as owing their origin to cold. Many of the more common and some of the most dangerous of the diseases of the digestive organs (stomach, bowels, &c.) are induced by this cause, as well as inflammatory affections of the kidneys. We know too that many diseases affecting the special senses, such as sight and hearing, are brought about in this way. But there is one class of ailments which of late years has engaged in a very special manner the attention of medical men, viz., diseases of the nervous system, embracing a large number of most important ailments, many of which are traceable more or less directly to the effects of exposure to cold; for as I have stated in a previous part of this lecture, the influence of a low temperature on this portion of the human economy is very marked. Many forms of neuralgia, which cause intense and oft-recurring suffering, are excited by this cause, and may sometimes be completely cured by an alteration in the mode of dress, which affords greater protection to the affected part. Paralysis, too, may be brought about by cold, a not uncommon form being that affecting one side of the face after sitting with it exposed to a draught of cold, which arrests the function of the nerve supplying the muscles of the face, and thus for a time paralyses them. But more serious forms of paralysis may result from cold. Thus I had recently under my charge for a time in the Royal Infirmary a strong young man who had entirely lost the power of both legs by paralysis, which was caused, beyond all manner of doubt, by his having got thoroughly wet, and gone about for hours without having a change of clothing. Other examples of nervous disease connected with exposure to the action of cold might easily be narrated. But time would wholly fail me were this part of the subject to be pursued further; and it does not indeed appear necessary to add more to a catalogue of maladies already both lengthy and grim, to illustrate the point laid down, viz., the possible consequences of a cold. It is altogether rather a sombre subject, and must, I fear, have had a somewhat depressing effect upon my audience; yet it is doubtful whether a regard to honesty in dealing with it could have imparted much brightness to facts which are but too often forced upon the observation of the physician, and which, as here recounted, do not err on the side of overstatement. I trust, however, nobody is the worse for what has been said.

The best and most hopeful part of my subject now remains to be briefly considered, viz., HOW A COLD IS TO BE AVOIDED. This is the conclusion of the whole matter, or its practical application. Time, however, forbids my dwelling on many points of detail that might profitably have been brought under notice. It would be mere presumption in any one to profess to indicate any specific plan which would infallibly secure against the taking of a cold. As long as humanity and its environments are what they are, colds will never cease from among the diseases of men. All that I or any one else could undertake is to furnish you with some general directions, the observance of which will go far towards diminishing the liability to suffer from this cause. I must at the outset lay down one or two principles which, although they may seem mere truisms, are, I venture to think, not always fully borne in mind, or given effect to. The first is, that health, to be preserved, must be looked after; and that not only when it threatens to give way, but when it is at its best, in fact at all times. No man can expect his business to thrive unless he attends to it systematically, and just as little has any man or woman a right to expect the business of their health to thrive unless they give it their attention. I do not say *all* their attention—that is valetudinarianism, and is either a disease or a sin—but their systematic attention, which is a very different thing. This is not difficult of accomplishment, and falls easily in with the general habits of life. Nevertheless there are few of us who do not err in this matter. We complain that these bodies of ours occasion us many of the sorest troubles and burdens of life, but how much fewer of both might there be were we kinder to them than we are—were we indeed only to give them fair play. It is truly surprising how long-suffering they are, and how often it is only after prolonged neglect and outrage that they, as it were, turn upon us and take a severe but not unmerited revenge. That the domain of Christian duty includes the care and the honouring of the body admits of no dispute.

If these remarks be true as regards health generally, how much more are they applicable in reference to those particular points of it which, from our surroundings, are pressed upon our attention, such for example as the influence upon us of a changeable, and often cold and ungenial, atmosphere. How necessary is it to be protected and armed at every assailable part, and how inevitably must laxity in this matter sooner or later bring its own punishment. I have told you how our bodily heat is generated by changes taking place within us in the processes of nutrition, and how necessary it is that this function be maintained in integrity if we are to escape the evil effects of cold acting on us from without. We must keep this internal fire burning by supplying it with coals, that is with food, and the supply should be regular and of good quality. Don't let it get low by too long fasts, and don't put rubbish in it which will not give any heat. Our food, as previous lecturers have shewn you, must contain a due proportion of the albuminous elements, and of the carbo-hydrates (starch, sugar, and fat). Both are necessary to the heat-generating process. Everyone knows how vigorously we can set ourselves to face a cold wind, when, with a healthy appetite, we have taken a wholesome meal, and if our meal be wholesome, in accordance with the principles I have just indicated, we need nothing more. This leads me to say a word on the effect of alcoholic stimulants as means for resisting cold. The popular idea, and too prevalent practice, of taking a glass of spirits to keep out the cold is a great and dangerous delusion. It does the very reverse. The immediate effect no doubt is to impart a sort of warm glow and exhilaration, but this is a feeling and not a reality. The nervous system is abnormally stimulated, and the action of the heart excited, but these are speedily followed by depression. Again the bloodvessels of the skin are fuller of blood, and in consequence more heat is radiated away from the surface, while the contractile power already referred to as residing in the skin is also impaired, and in these various ways cold is able to exert its hurtful action, while the means for resisting it are greatly lessened by the alcohol.

In this matter the experience of Arctic voyagers and others who have had the opportunity of fully testing it is in entire agreement with the teachings of physiology. Dr Hayes, the celebrated American Arctic explorer, declared that alcohol taken for the purpose of resisting cold was "not only completely useless, but positively injurious;" while the experience of the officers who accompanied the Red River Expedition, under Sir Garnet Wolseley in 1870, was that while the troops had as arduous work to perform as ever fell to the lot of British soldiers, they continued throughout in excellent health although not a drop of drink was given, the only beverage being tea. Numerous other instances of a like kind could be cited did time permit. Depend upon it, then, that the man who by a single glass of spirits places himself under the influence of alcohol—in a scientific, if not in a conventional sense—is far more liable to suffer from cold than he who has fortified himself simply by sufficient and suitable food. In cold weather the food should be greater in quantity than at other times—this is indicated by our increased appetites—but it should likewise have more fatty matter contained in it, to promote the heat-making process within us. This is especially necessary in the case of the young and the delicate as a means, and a very valuable one, for resisting the action of external cold. Such articles of food as cocoa, milk, bread and butter, may be taken by most persons, even by those who cannot, or will not, eat meat containing fat. The value of a daily small dose of cod liver oil for those, whether young or old, who shew a liability to suffer from colds is very marked. This substance is a food as well as a medicine, and possesses properties which render it easy of digestion, if rightly administered as to time and quantity. It should be taken either after a meal, or near bedtime—probably the latter answers best on the whole; while the quantity need not be large, a single teaspoonful or little more being quite enough. Many a cold, and many a serious and fatal illness might be averted were this practice carried out systematically during a winter, particularly among children.

Attention to the skin is of the very first importance as a measure for enabling us to withstand the injurious effects of cold. It is, as has been already stated, chiefly by the skin that we catch a cold, and it is certainly by the skin that we may most successfully prevent a cold. The relation of the skin to the general health has been amply demonstrated to you in a previous lecture, and I can say nothing to emphasize the wholesome lessons therein conveyed. It is with the care of the skin in connection with the catching of a cold that we have at present to do, and there are two aspects in which this subject is to be considered. The one is the maintenance in its vigour of the function of the skin, and the other the due covering and protection of the skin. As to the first, bear in mind the facts already brought before you in reference to the structure of the skin, and to its various functions; how it is to be regarded not merely as a covering for the body, but as an organ of the body, consisting of fibrous tissue, cells, glands for sweat and oil, also innumerable bloodvessels and nerves; and possessing in addition to the property of carrying off effete matter, the power of regulating to a large extent the bodily heat. To fulfil all these important offices aright it must not only be unclogged of the matters that are apt to accumulate on it, that is, dirt, and kept thoroughly clean, but also be preserved in a state of good tone, and readiness to act, as we know it is often called upon to act, suddenly, on its defence and the defence of the system generally, when subjected to the assault of cold air. The regular practice of washing and bathing are essential for both of these purposes. It might seem almost impertinent for me to advocate the obvious and natural duty of washing and cleansing the skin, but frequent medical examination of the persons of individuals, particularly in hospital practice, too often reveals a state of things which shews that this advice is not by any means uncalled for. There seems to be a tendency—there is no doubt a temptation—to limit the ablutionary efforts to those parts that are exposed to view, while Nature is compounded with on very easy terms indeed for the rest, to the manifest injury of the health, no less than to the disgust of the unfortunate medical examiner. I say to the injury of health, for if you will recall what was stated as to the number of pores on the surface of the body (about 2,300,000), you will easily understand that if the most of these are closed up by dirt, the whole system must suffer, and the skin itself be enfeebled in function, and less resistant to cold. But in addition to the purposes of cleansing the skin, washing and bathing the body are very important as tonics for the skin, that is, for keeping it in vigorous operation. The genial glow and pleasurable lightness both of body and mind which follow the cold bath and brisk rub down with a rough towel, would be recompense enough for the effort of self-denial or compulsion, which, on a cold morning, has to be put forth in undertaking it; but there is far more in it than this. For this plan of treatment of the skin, if systematically carried out, induces a healthy action in each single part of its structure—cells, fibres, nerves, vessels, &c., and confers on the whole a vigour of tone which, if it does not afford complete immunity from catching a cold, goes far towards it, since the surface is seldom surprised by any sudden change of temperature, and reacts powerfully when it is. The bath should, if possible, be of cold water, but no absolute rule should be laid down on this point, much depending on the power of reaction, and the presence or absence of the feeling of glow which follows it. There are some persons to whom the cold bath is intolerable, some to whom it is positively dangerous. Very young children, delicate persons, and those advanced in life, should not as a rule have the bath cold, at all events in winter, but the temperature of the water should be raised so that shock may be avoided. In any case, the subsequent thorough rubbing with a rough towel is of scarcely inferior importance to the bath itself. There can be little doubt that were the bath with friction of the skin regularly employed by those up in years—and the habit, if acquired, can be easily carried on—much suffering and disablement from bronchitis or winter coughs might be avoided, as well as many of those troublesome forms of skin disease so often met with. As a means for preventing colds the bath is only of use if employed frequently, daily if that can be, if not, then as often as possible, and with regularity. We are all too well aware that the carrying out of this practice in a large proportion of our smaller houses is in great measure prevented by the absence of the means, viz., the bath, and even the most zealous in this cause has often to be content with an unsatisfactory substitute in the shape of a daily rub down with a wet towel or sponge. The obvious remedy for this, and a most desirable sanitary measure, is the establishment of public baths on a sufficiently large scale. It was a welcome announcement which was made here the other night by the Convener of the Health Committee of the Town Council, viz., that this matter was engaging the attention of that Committee, and of the Medical Officer of Health for the City, and we may be sure that in such energetic hands it will not be allowed to rest. Such a public blessing cannot come a day too soon—as blessing I feel sure it would be regarded by the working people of Edinburgh.

The next point as regards the skin is its covering. Our skin, however healthy, must be protected by clothing, which will prevent the too great access of external cold on the one hand, and the too abundant radiation of heat from the surface of the body on the other—in short, which will keep out the cold, and keep in the heat; and such clothing, therefore, particularly that portion of it investing the skin, should be made of comparatively non-conducting material, such as wool, which is infinitely the best for this purpose. The utility of flannel underclothing is generally recognised, although there are not a few individuals in all classes of the community who affect to despise such measures of precaution, under the notion that they keep themselves hardier by avoiding them, and many persons, no doubt, do avoid them with impunity. But in a climate like ours, with its extraordinary changeableness and extensive prevalence of damp and cold, this cannot be done without serious risk even by the most robust. The neglect of flannel for young children is little short of criminal, when we consider how extremely susceptible their respiratory organs are to inflammation brought on by cold. It is impossible to believe that that appalling mortality from bronchitis in children under three years of age to which I have referred, would have been anything like so great had every one of these infants been properly clothed, fed, and cared for. The irritation produced in some by flannel induces them to wear it over a cotton or linen garment in immediate contact with the skin, which of course is better than no underclothing at all, but such irritation is in most instances entirely got rid of after a time, and should it not, then some softer material, such as merino, might be tried. Chamois and other skins, though pleasant, are not so healthy. The underclothing, if of suitable material, need not be very thick, for this is apt to oppress us when we sit in a warm room, or when the weather takes a mild turn. The flannel should come high up on the chest, a point much neglected by women, who often suffer from their having a large portion of a locality of the body most susceptible to cold comparatively uncovered. The so-called 'chest protectors' worn by many delicate persons, if made of flannel and adapted to the back as well as front of the chest, are likely to be a defence against the catching of a cold. The expense connected with obtaining good underclothing will certainly repay itself and is the soundest economy in the end. The upper clothing should also be of good cold-resisting material, but if the underclothing be ample as to amount and quality, no great advantage results from heavy outer garments. Thick top coats, except for very severe weather, are often a great burden, and to those who are much in the open air, an upper coat of not too thick material is better. Weight by no means implies warmth. Thus in one of the industrial schools in town with which I am connected, the infant children as well as the elder ones were attired in suits of that hard and unkindly material called moleskin, which simply hung upon them and weighed them down, affording very little warmth. A change was made to tweed, and the result was soon apparent in the comparative absence of colds, chilblains, and other winter troubles, which had been before so common.

As to female attire, much might be said did time permit, but only a general remark or two can be made. Even to one possessing so little technical information on these matters as myself, it seems possible to discern in their management of late years the presence of more rational principles, and to find that the dictates of health are to some extent, at least, contesting the sway of imperious Fashion. Nevertheless, it cannot be denied that many of the modern modes of females' dress are not conducive to the maintenance of a robust body—a fact of momentous importance when viewed in relation to the well-being of future generations. There is reason to fear that much infantile delicacy and infantile mortality are directly the result of present or past inattention to their own health on the part of mothers. The tight waists, and tight and thin coverings for the hands and feet, operate powerfully in producing colds and their effects, since they interfere with the healthy circulation of the blood in the skin, and reduce its resisting power. The frequent neglect of flannel, or its partial and inadequate employment, have a like effect. Rely upon it, that the more sound sense, enlightened by a knowledge of the laws of health, prevail in regulating the manner of woman's attire, although there may be some figures less gainly, and some hands and feet a trifle larger than their owners would like, the grand result would be lives saved, suffering averted, a large increase in the presence among us of typical female humanity, and greater aptitude and power for fulfilling the noble part in the world of her sex. The dress of children, particularly girls, is [also open to many objections, and is only defensible on the condition that ample warm underclothing is worn. Every other means calculated to promote the invigoration of the system will to that extent enable us to avoid a cold. Regular outdoor exercise, regular meals, regular hours, early rising, and sea-bathing in summer, are all helpful to this. Means for strengthening those parts most liable to suffer from a cold, such as the respiratory organs, should not be neglected, particularly among the young: moderate gymnastic exercise, skipping ropes, chest expanders, dumb-bells, etc., but especially the practice of singing, which assuredly tends to the nutrition of the lungs, and the development of the chest. It is pleasing to think that the teaching of singing is now so general in our schools, as its bearing upon the promotion of the health is most important; but it should be practised at home as well as in school, and by grown people as well as by children, provided, of course, they are in good health. I cannot help thinking that if there were more singing there would be less coughing.

A word to those who are susceptible to colds. To avoid them more than the ordinary precautions already dwelt upon require to be taken. Keeping the extremities, especially the feet, warm is of great consequence, and for this purpose, besides warm stockings and stout boots or shoes, an inner sole of felt, flannel, or cork is useful. They should, when in the open air, endeavour to keep moving, and they should breathe, as they were intended to breathe, by the nose and not by the mouth. When out in cold winds the neck should be covered by a muffler or cravat, which need not be thick, but sufficient to protect the skin from chill in that locality, which appears to be a frequent manner of our catching cold. Indoors equal care is necessary to avoid draughts and cold rooms. I am no advocate for fires in bed-rooms, but they are sometimes necessary when the room is large, and there is a tendency to cough after lying down and during the night. The practice of sleeping with an open window in winter is not safe, at all events in the case of the delicate or the very young. Colds may be caught in bed, and therefore there should be ample covering to the body by bedclothes, and by night-dress, which in children should be long and of woollen material. When there is a liability to frequent sore throats, a regular night and morning gargling with cold water all the year through will avail much

Perambulators are now so thoroughly an institution of our day for the locomotion of young children that it would be vain to attempt to discountenance them. In winter, however, they are often the cause of their occupants catching colds, when used in biting winds, or when allowed to stand while those in charge of them are enjoying a talk with a friend, or when the body and limbs of the child are not abundantly wrapped up.

Lastly, let me say that when we feel ourselves chilled and tending to shiver, we should try to put forth a strong effort of the will to resist the feeling, for much evil I am persuaded may often be warded off in this way. If, in addition, we can promptly have recourse to a hot bath for the whole body, and a hot drink —tea, coffee, gruel, etc., are better than alcohol—a cold which might otherwise produce serious results may often be extinguished at the onset. This, however, leads me to the confines of my subject, and to pursue it further would be, as the lawyers say, "travelling beyond the record," for you will observe my lecture did not include the treatment of a cold. This may, perhaps, form a subject for future discussion, for the whole topic is one that is much too large for a single lecture, and I have had to deal with it in a very sketchy manner. If, however, anything which has to-night been brought under your notice should produce in any of my audience a higher sense of the value of possessing, and the duty of conserving, the God-given blessing of health; or if it should be the means, in any measure, of preventing the evil consequences which we have seen are apt to arise from the hurtful action of cold upon our bodies; above all, if it should be instrumental in saving a single life—even the life of a little child, great indeed would be my satisfaction and thankfulness.